The Dock and Harbour Authority

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Editorial Comments

The Fishery Port of Vigo.

A year ago (to be precise, in July, 1943), we published an article on the Portuguese fishery port of Peniche. As a sequel to it, we are including in this month's issue a parallel article on the Spanish fishery port of Vigo. Both are located at no very great distance apart on the Western Coast of the Iberian Peninsula and, therefore, have common interests in the neighbouring fishing grounds.

There is, however, a distinction between the two in that Peniche is relatively a small community of some 7,000 inhabitants, almost entirely dependent on its fishery industry, while Vigo, on Vigo Bay, is an important town with a population more than ten times as great and with considerable commercial activities of a general nature. The former harbour, too, is mainly artificial, while Vigo Bay provides a fine natural recess with a convenient entrance and excellent shelter. There is safe anchorage in front of the town for large ships, about 2,000 acres in extent, and an additional 600 acres for smaller craft. Breakwaters are already in existence and the major work in hand is that of providing quayage and marketing facilities for the fishery harvest. Of the national value of this harvest, there can be no doubt, since, as pointed out in the article by Engineer-Director Fernández, the fishery contribution to the Spanish Exchequer, is second in financial importance in the national budget. Moreover it enables Spain to rank as fourth among European fish-providing countries and ninth in the whole world.

The facilities and equipment for dealing with the catches, thoroughly modern and up-to-date as they are, will be studied with much attention by harbour authorities engaged in the fishery trade. There is a vast array of factories and stores for the treatment and preservation of fish, as well as for its packing and canning, which provides employment for thousands of employees and sets Vigo in the foremost file of such establishments in Europe.

It is noteworthy that from a military point of view, Vigo has had associated in the past with distinguished British Commanders, by whom it has been several times attacked—by Sir Francis Drake in 1585 and 1589 and by Cobham in 1719. Sir George Rooke captured and destroyed several French men-of-war in Vigo Bay in 1702, during a war with France and Spain, immediately after Queen Anne ascended the English throne.

South African Port Control.

In order to give our readers as wide and comprehensive a picture as possible of systems of port administration in vogue in different countries, together with well-informed observations thereon, we are glad to include in this issue an article from South Africa by a writer who, it may be mentioned, spent ten years of his earlier business career in the docks of the London and India Docks Joint Committee, one of the predecessors of the Port of London Authority. Since 1902, Mr. Liddiard's work has been connected with the ports and harbours of South Africa and he is now an enthusiastic exponent of the advantages which he conceives to be gained from a State-controlled amalgamation of port and railway administration.

That certain features of the arrangement are beneficial will be freely admitted, but, at the same time, it must be borne in mind that port conditions in South Africa are essentially different from those in this country. The ports of the Union, all told, are not more than half-a-dozen in number and only two or three of these are of significant importance. There are few, if any, competing interests to antagonise them commercially. They have ample and well-defined hinterlands, which are served by the single railway system to which they are all attached. Moreover, road haulage services appear to be definitely under the influence of, or at any rate to be worked for, and in conjunction with, the railway administration, so that rivalry between these two forms of inland transport does not present a problem so acute as it does in this country.

Comparison is further differentiated by the fact that the Railways and Harbours Administration of the Union is a government department, with untrammelled and practically autocratic, powers, and therefore, beneficially or otherwise, exempt from interference by private enterprise. We have already indicated that in our view such a system would hardly meet the needs, or accord with the wishes of the great majority of people in this country, with their native genius for, and long tradition of, successful individual initiative. To this may be added their instinctive aversion from all avoidable association with bureaucratic formality and red tape.

None the less, it is a good thing to take into attentive consideration alternative systems of port administration and to weigh their merits dispassionately. There are examples in Great Britain of

Editorial Comments – continued

leading ports under railway management, without, however, the complication of state control. By reason of the manifest efficiency of their working, the divorce of these undertakings from railway ownership was not advocated by the Royal Commission on Transport, though the Commissioners expressed the opinion that " in principle it is undesirable that one form of transport should own docks and harbours to which access by other forms of transport is essential."

Port Amalgamation.

We have to record a striking move in port policy in Great Britain. The recent appointment by the Minister of War Transport of an Inquiry Committee to investigate the administration of port and navigational facilities on the River Clyde, as set out in precise terms on a later page of this issue, is the first and, indeed, a momentous step taken in the direction of port amalgamation in this country. It may well be the precursor of a series of similar inquiries in other localities, resulting, it is to be hoped, in the elimination of superfluous authorities and conflicting jurisdictions.

We have previously expressed the view that, while the wholesale absorption of ports within a national control administration is not a commendable ideal, yet there are a number of cases in which closely contiguous ports, with identical, or similar, interests, might advantageously be grouped in a single entity for the purpose of more effective working. The Clyde is a case in point. There are on its banks four segregated ports of greater or less importance. Glasgow, of course, is pre-eminent; in addition, there are Greenock, Port Glasgow and Dumbarton, the last two being of minor standing; indeed, there has been a movement of late to abolish the Harbour Trust of Port Glasgow, since there is little or no trade movement and the harbour is practically closed to shipping.

Whether the individual interests of this group of ports will admit of closer co-operation is the question which the Inquiry Committee have to decide. There is certainly one common element of activity in them all, viz., Shipbuilding, for which the Clyde is famous throughout the world. Apart therefrom, Glasgow has a substantial trade in general cargo, which has necessitated continuous extensions to the chain of so-called docks on both sides of the river—they are really open tidal basins and not docks in the strict sense of the word. There are also considerable exportations of coal and iron and steel manufactures, while timber is a leading import. The staple trade of Greenock is in sugar and its products: the town is the sugar-refining centre for Scotland. Another extensive business is that of fitting out with engines vessels which have been launched on the Clyde, and local firms engaged in this work are of world-wide repute.

The co-ordination of these various interests interests within the jurisdiction of a single port authority, if found practicable, will certainly require careful thought and negotation. Geographical proximity in itself is insufficient to justify, or does not necessarily justify, port amalgamation; it must be fortified by other arguments. Certain factors, apparently superficial and unessential, may nevertheless exercise a powerful influence and, if the association is to be durable as well as beneficial, such matters as local patriotism and trade rivalry must be taken into account. It would be unwise to run counter to strong popular feeling.

In this connection we are wondering what progress has been made by the Dock and Harbour Authorities' Association with their own proposals for the co-ordination of port administration. It is understood that a special committee of the Association has been engaged for some time past in the preparation of a report on the matter, which, we suggest, it would be timely to publish in advance of piecemeal negotiation.

Cargo Containers.

During a visit to North American ports some years ago, we were much impressed by a practice adopted in connection with railway freight, viz.: that of handling it in huge wooden casings, or containers, which were packed to capacity prior to transport. It seemed to us that it would be a means of saving time and labour at the ship-side, since the container would simply require lowering into the hold without the trouble of stowing numerous individual packages. Naturally, it would not be applicable in all cases and to all classes of material—steel rails, for instance, and timber planks or logs. Still, there is a large assortment of freight in the form of miscellaneous parcels which could be compacted within the limits of a good-sized container. Those containers which we saw were 18 or 20-ft. long and 7 to 8-ft. square section. They had a load capacity of about 20 tons apiece, and were handled by heavy lift cranes, or special booms.

We now see it reported that the idea of applying the method to shipment is gaining ground in the United States. In the New York *Journal of Commerce* there has recently been published an article giving details of a cargo vessel specially designed for the reception of containers. It is to operate on the Great Lakes and is expected to cut down stevedoring costs very considerably. Indeed, the estimated reduction is from a present average of $1.20 per ton to as low as 15 cents per ton.

The chief obstacle in the way of the economical handling of general cargo is the wide range of sizes, shapes and weights which it exhibits. If a greater degree of standardisation could be adopted, there would be a corresponding saving of time and labour. But in view of the variety of commodities, it is not easy to see how any general and acceptable package standard can be devised though something might be done towards that end. The advantage of the container lies in the orderly assemblage of the various units within the limits of its capacity. There are certain obvious objections which can be raised, but in our view these can be met, and none of them would appear to be insuperable.

Studies in Stevedoring.

The art of stevedoring, more particularly as regards the loading (as distinct from the unloading) of ships, involves many problems in the way of compact stowage to the best advantage, so as to secure the maximum amount of cargo within the minimum amount of hold space. The knowledge how to deal with these problems can, generally speaking, only be acquired in the course of extensive practical experience. Information can certainly be obtained from a few books on the subject, but such instruction is necessarily limited in scope and application. Stevedores have to rely more on their personal judgment than on theoretical principles, however soundly enunciated.

In this connection, it is interesting to note that in the United States, the efficient training of stevedores is being fostered at a school established for the purpose at the Port of New York. Furthermore, the school, unique of its kind, is equipped with a working model of a merchant ship, which must surely also be unique. It is a scale model (27-ft. in length) of a Liberty Ship as constructed in the United States, complete in every detail as regards cargo-handling appliances, with derricks, booms, falls, capstans and winches, capable of being operated with models of freight packages of all kinds and varieties. The ship, indeed, is constructed on the lines of a doll's house with a removable side, so that the interiors of the holds are open to complete inspection and the stowing of packages to the best advantage can be demonstrated. Moreover, the ship is berthed alongside a miniature pier, appropriately furnished with a quay shed and its appurtenances. The locus being American, we imagine this does not include quay cranes, the place of which will be taken by shed cargo rails, pulley blocks and winches.

Designed primarily to meet the exigencies of war service and to provide a supply of rapidly trained, but competent, stevedores to deal with military stores transhipped from the United States to Europe, the idea is highly commendable and might well be adapted to future peace-time conditions. No little credit is due to Mr. Andrew Nelson, of Messrs. T. Hogan & Sons, stevedores to the United States Lines, for his vision and enterprise in setting up the school in the Port of New York. So far, something like 1,500 officers, ranging in rank from warrant officer to commander, have passed through the school and gained experience which must have been of great value to them. As it was foreseen that the trainees might be called upon to load and unload ships in undeveloped harbours and on open beaches, even under fire from enemy guns, they were taught how to rig emergency booms and sheer legs and to substitute auxiliary power in the event of the ship being unable to supply its own steam.

The Fishery Port of Vigo*

A Leading Spanish Industrial Centre

By MANUEL ESPARRAGO FERNÁNDEZ, Engineer Director of the Vigo Harbour Works.

Spanish Fishery Industry

THE fishery industry represents one of the prime sources of revenue in every country, and its contribution to the national exchequer in Spain ranks as second in financial importance. During the last three years, the annual catches have exceeded 400 million kilogrammes (1 kilo = 2,204 lbs.), and for the year 1942 have contributed to the nation's resources, at their first marketing, more than 1,000 million pesetas.

Based on her fishery output for 1939, Spain ranks as the fourth among European fish-providing countries, and as the ninth when the survey is extended to include the whole world.

This revenue asset is obtained by the mobilisation and activity of more than 34,000 vessels, totalling 184,000 tons and manned by 236,000 people as crew ratings, whose lot it is to contend daily with the caprices of the ocean and who must track their quarry at localities so far apart as the shoal beds of Grande Sole or of Africa, covering more than 1,000 nautical miles and occupying several weeks of sailing.

The average citizen whose outlook is bounded by his house surroundings can form only a vague idea of the perils and dangers to which the calling of the deep-sea fisherman exposes him, and not until he visits some fishing harbour and observes the arrivals and departures of the steamers and their unloading at all hours and in weather sometimes the most inclement, and notes how they disappear again over the ocean after a rapid re-equipment and revictualling, does he begin to realise something of the magnitude of the enterprise and labour involved.

Life and labour on the deep sea are hard and pitiless—icy colds, damp atmospheres and extreme risks—but all dangers are brushed aside or trampled underfoot though, occasionally, they must be faced as incidents of one's personal destiny.

It is hardly possible for the stay-at-home to enter into the feelings of the fisherman when he arrives safely in a harbour, and it may be unnecessary to add that his mind must have been purged of the last vestige of fear or foreboding. He must, no doubt, have some feeling of added security when touching the mainland, where he anticipates a sheltering harbour in which not only his ship will be moored in safety but where also the cargo it carries will find a ready sale and yield a satisfactory return for the labour and risk, without delays that would deteriorate it and without fear that he may be victimised by some greedy usurer or monopolist.

Importance of Fishery Industry to Vigo

Above all, it seems desirable to put on record the outstanding importance of the fishing harbour of Vigo by detailing seriatim the total weights of the catches, as also their monetary values for the last ten years:

Year	Catches in thousands of kilos	Value in thousands of Pesetas
1932	39.6	18.6
1933	44.8	21.4
1934	52.9	27.4
1935	63.8	27.9
1936	47.1	21.7
1937	70.6	26.4
1938	58.9	45.0
1939	46.4	78.4
1940	52.5	85.7
1941	39.0	93.7
1942	32.5	87.2
1943	44.0	102.5

As will be obvious, the output represents a high percentage of the total fishery revenue of Spain, which is derived from more than 250 ports, large and small, distributed over the long line of its sea frontage.

The advantage of being a primary marketing site is, in the case of Vigo, enhanced by the speckless cleanliness that marks the treatment and conservation—an occupation that forms the livelihood of many families—and also, on a larger scale, in the factories where the same standard of scrupulousness prevails.

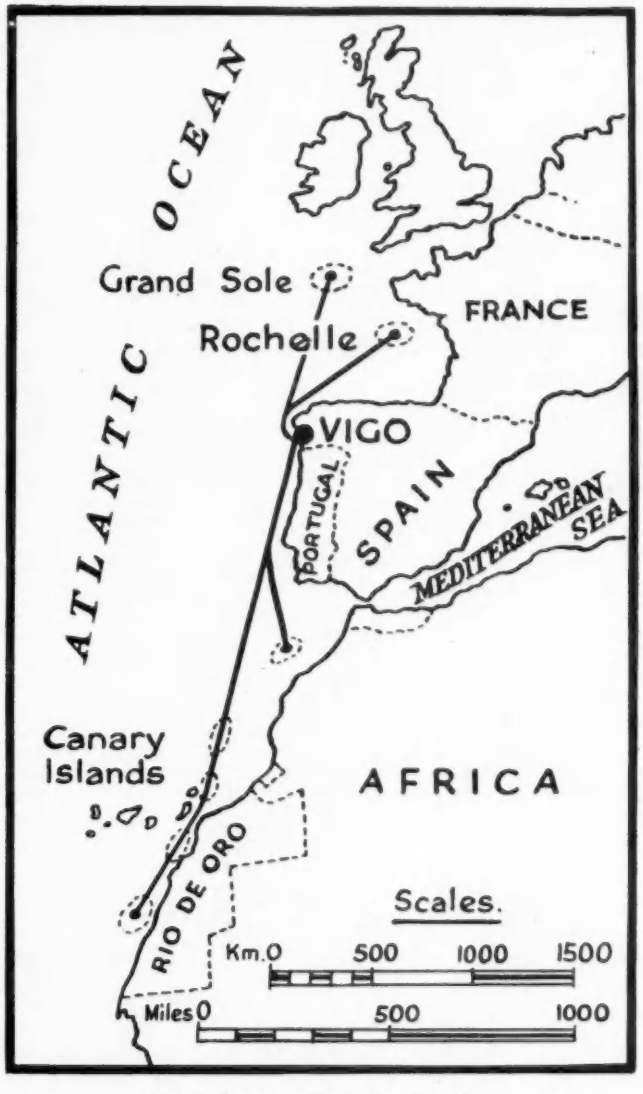


Fig. 1. Diagram Illustrating Location.

These industries, established and housed along the entire estuary, provide employment for 7,000 persons, and the factory where they work has an output capacity of 500,000 packing containers (cases) holding 50 million tins; it is the foremost establishment of its class in Europe.

The figures just cited, are those denoting peak limits and do not represent the normal traffic, but something widely different,

*Translation from Spanish of Article published in the *Revista de Obras Publicas* issue of February 1st, 1944.

Fishery Port of Vigo—continued

for the catches vary in the most extraordinary manner from day to day in the same month and from month to month in the same year, the weight of the haul being on many days in excess of 300,000 kilos and on several reaching as high as 500,000 kilos.

A reminder must be added here that the fishing fleet of Vigo, which is constantly being amplified and extended, is the one holding primary place in Spain, and that its component vessels, though they may be transferred to other harbours, still definitely acknowledge Vigo as their home base.

It comprises 917 vessels representing 22,424 tons and a monetary value of 93,576,000 pesetas, without including the craft of Cangas and Bayona which are estimated at 1,570 vessels totalling 4,151 tons and valued at 8,695,000 pesetas, which are marketed, for the most part, in the Port of Vigo.

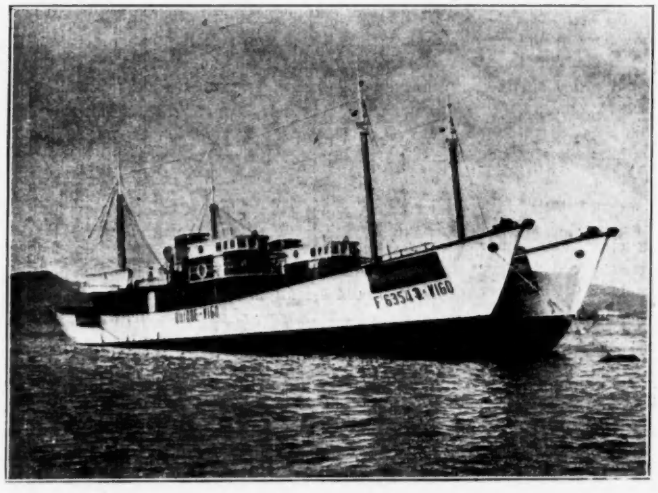


Fig. 2. Motor-driven Fishing Craft with Steel Hull; Standard Barreras.

It is very interesting as well as important to take note of the type of craft construction adopted in Vigo. The dockyards, also, in Vigo are very numerous as are, too, the wharves, some of which are of of unusual size which have given ample proof of their technical skill in the construction of vessels that are thoroughly up to date. It seemed necessary to present this cursory view of the extent and ramifications of the industry itself as a national asset, quite apart from its strictly economic interest.

The fishery port is not merely the exchange mart, but the accelerated development of the fishing industries with their allied branches and annexes rendered it necessary, within a very short time, to lease and occupy the entire coastal area, extending from Berbés to Bouzas.

We have always harboured a keen interest in this industry; the authorities have courteously granted us every facility and have vied with the Ministry of Public Works, which, for their part, have evinced a keen solicitude in the welfare of the whole fishery trade. In the month of December, 1938, when Europe was already plunged in war, they sanctioned and approved a " Plan for the erection of this first group of dwellings in the fishery port " and straightway authorised the beginning of the works.

Later, they continued to aid the execution of the plan and quite recently gave their approval to an improved scheme which was outlined in the following terms:—

> " The fishery port of Vigo may be described as the foremost in Spain when regard is had to the quantity of fish caught and distributed by the installations extant there. This is borne out by the fact that, during the year, 1942, the value of the fish landed there amounted to more than 87 million pesetas, from which the authorities and other fiscal Boards derived a rich revenue, while, at the same time, helping to replenish the national exchequer in a very substantial manner. In consequence all that was necessary was merely to nurse and watch over this industry as they have, in fact, done by the construction and equipping of the fishery harbour of Vigo."

When regard is had, as already indicated, to the methods adopted in other harbours, such as Ymuiden, Lorient, Grimsby, Cuxhaven, Wesermünde, etc. and the stipulations laid down by the XIVth International Navigation Congress which have been put into practical realisation in the large harbours referred to and when, further, account is taken of the Royal Decree of November 24th, 1926, endorsed by the Royal Decree of February 7th, 1928, one begins to realise the complexity of the requirements that have to be satisfied by a fishery harbour of the size of Vigo and their successful realisation by plans drawn up with a prescience equal to any emergency, the overruling axiom being that:—

> The fishery port necessitates, as its characteristic feature, an assemblage of structures awaiting their monetary equivalent in fish landed at the site, and is further characterised by two features—its very high value to the nation and its essentially delicate organisation.

Conditions Obtaining at Vigo

The general conditions which were required to be met and fulfilled in the case of Vigo were as follows:—

A sufficient water area to afford shelter to all vessels that might seek accommodation there, with due allowance for the fact that the number of these might surpass that originally scheduled for. There had also to be docks with quay berthage of adequate length and water-depth to allow of the fish cargoes being rapidly discharged. Further essentials were a commodious ingress for large fishing vessels, a zone reserved for vessels to moor for any period desired, with facilities for their provisioning with ice and fuel. Requisite are also the equipment and installation necessary for the handling and treatment of the fish and their rapid despatch to the centres of consumption; halls in close proximity to the landing sites where the fish may be displayed and sold; and, contiguous to these halls, there must be sheds for cleaning and packing, ice factories, refrigerators, a factory for fish meal, an acreage of sufficient extent to allow of goods easily reaching the harbour properly so called and to facilitate the maintenance of subsidiary and allied industries vital to the fish traffic, with well-paved streets to provide easy communications and connections; finally, railway sidings behind the sheds mentioned, readily connected with the main railway system.

These basic conditions had to be satisfied, while also taking account of two special circumstances—the special peculiarities of the fishing traffic in the harbour of Vigo and the constructions already existing.

Fish Classification

The fish themselves are, as is well known, classified under two categories:—

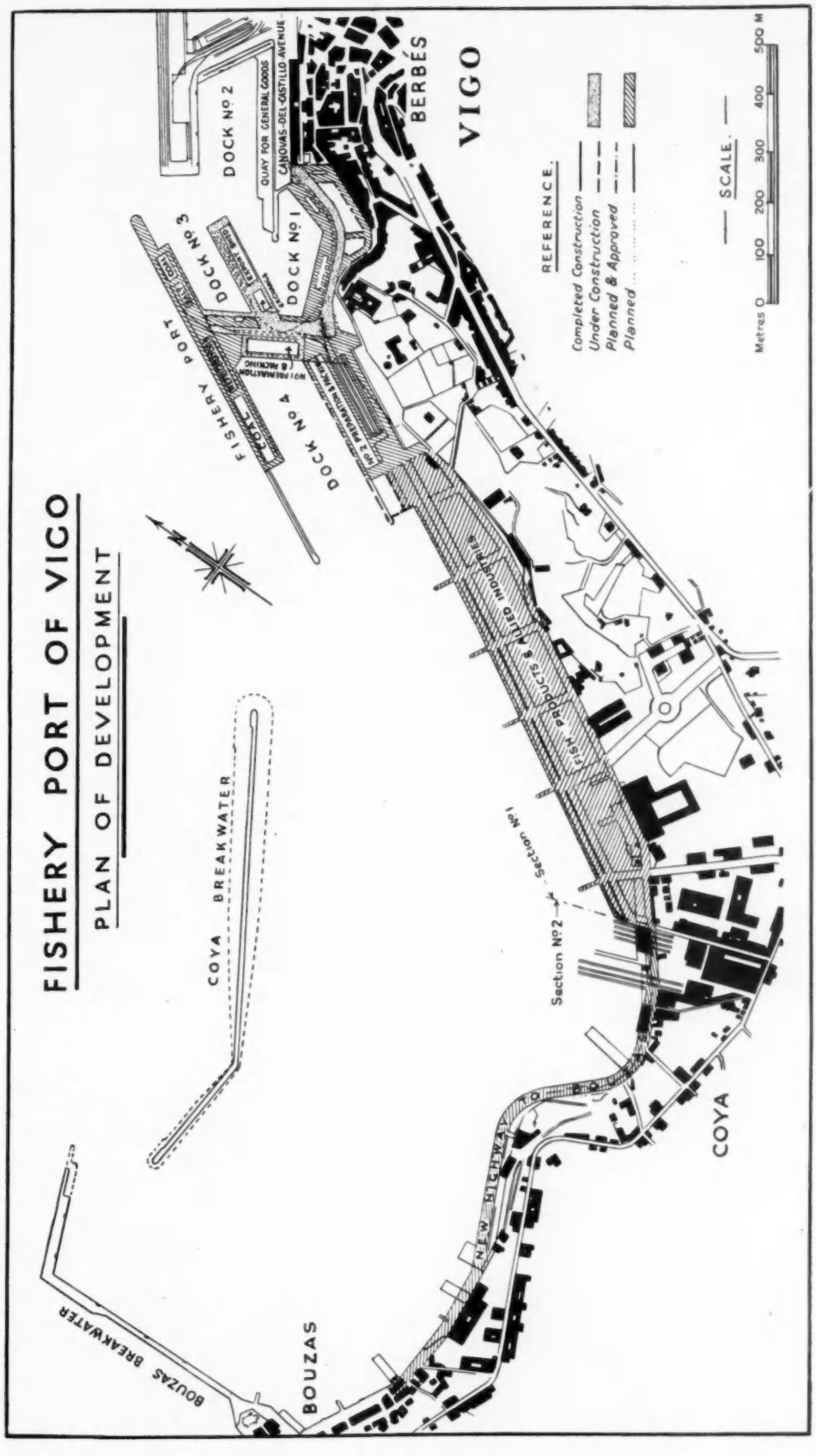
Large, deep-sea fish caught by nets cast by twin boats operating together, or by trawlers which operate by dragging and aim chiefly at catching such fish as the hake, small hake and predatory fish such as conger, ray, etc.

The shore and shallow water fishery, operated with smaller vessels, steam launches, many of them called motors, motor launches and smacks which, by enclosure, aim at trapping the sardine, the parrocha and other small fish, and by means of a multiple-hook line, the striped tunny, castaneta and ollomol.

Under this group must also be included scallops, ling and fish that are caught by dragging, the craft engaged in this branch comprising the numerous, smaller vessels that participate in every type of fishing and more particularly, for the calamar, cuttlefish, etc.

The fish comprised under the first group and that from the skiffs are landed in their entirety and displayed for sale in purchase vessels by auction in lots, whereafter they are transported by the buyers to their pre-treatment sheds, where the fish are washed with salted water and packed in ice for transport by lorry or truck to the interior of the country. The part intended for local consumption may pass direct to the sellers, or, by an improved method recently adopted, may be washed and stored in refrigerating chambers, by which means an enhanced regularisation in the local sales is effected.

The fish belonging to the second group, excepting those from the skiffs, is destined, for the most part, for the conserving and seasoning industries and is auctioned by samples in the market



The Fishery Port of Vigo

Fishery Port of Vigo—continued

hall; this may not involve the unloading of the fish in the harbour, but almost always its transport, after allocation, to the factories in the same vessel.

Nor is it necessary that the auction hall should be of excessive dimensions which, in the last resort, may depend on the number of sellers and purchasers, and even in the event of the fish being intended for cold consumption, it may be taken direct to the pre-treatment and cleansing sheds erected in other parts of the harbour site.

There is a further feature which differentiates to a marked degree, these two groups:—Whereas, in the first group, the auctioning is done at stated and fixed hours, in the case of the second, the sales begin immediately the vessel touches the mainland, at whatever the hour of the day or night this may occur.

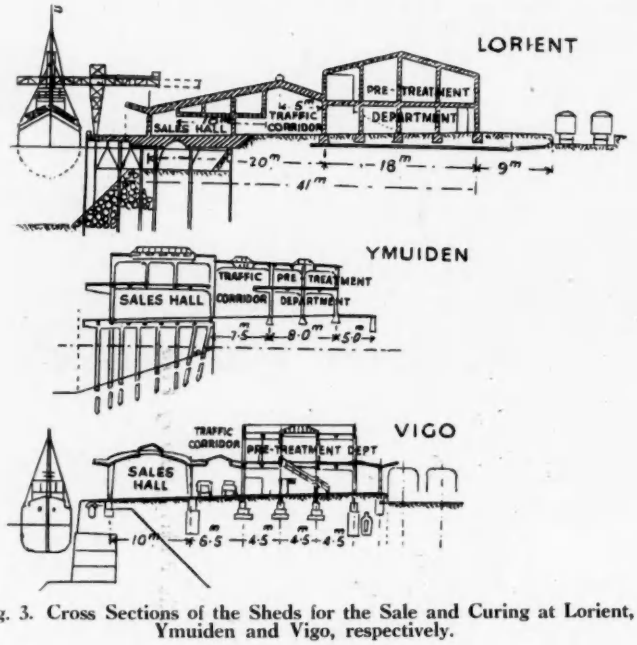


Fig. 3. Cross Sections of the Sheds for the Sale and Curing at Lorient, Ymuiden and Vigo, respectively.

Dock Accommodation

In Berbés there are at disposal a series of inter-communicating dock basins, Nos. 1, 2 and 3; the latest, as yet unfinished and self-contained basin, No. 4, has the greatest surface area and water depth of all. In view of its segregation from the other docks, it is intended, most probably, to be used for fish such as the deep sea catches, a group apart, and we have already noted that this category of fish is characterised by the hull vessel and the use of ice instead of salt so that the segregation is simplified. It was, however, necessary to incorporate in this dock the shore breakwater already under construction.

It presents, furthermore, the advantage that the major percentage of the deep-sea fishing fleet regards Bouzas, generally speaking, as its base for resting, repairing and revictualling, and as the Berbés docks are utilised solely for the unloading of the fish and the taking in of ice and fuel, they retain their utility for such purposes by being so close at hand and through their excellent sea communications.

The wharf at Bouzas is not large enough for the fleet of vessels that might repair to it, and steps are being taken to enlarge its approach roadsteads.

When the proposed extensions are completed, there will, in due time, become available, for the fishery port, in so far as flotation surface and roadsteads are concerned and without including the Bouzas zone, some 9.52 hectares of water surface and 1,900 metres length of roadstead, with a water draught of 2 to 7 metres.

No such happy results can be obtained from the zone of the harbour's environments, which, though they may be readily extended, will yet remain inadequate. When the work connected with the shore breakwater of the dock No. 4 is completed, a surface area of 11.65 hectares will become available for installations, but practically the whole of this terrain is absorbed by streets, roads, loading and unloading zones and service buildings devoted to the immediate exploitation of the port, with the result that hardly any ground room will remain for the subsidiary but vital allied industries.

This deficiency is, in part, counterbalanced by the road communicating between the docks of Berbés and Bouzas and the packing sheds.

Another benefit anticipated from this construction will be the elimination of the enormous drawback due to the lack of communication between the fishery harbour and the water edge, while some 58,000 square metres of ground will become available for operation, while, simultaneously with the maintenance of this magnificent public service, the revenue derived from the renting or sale of the grounds in question amounts to more than 3,000,000 pesetas.

In its planning, a different frontage has been adopted in Section No. 1 from that in Section No. 2; in the former, the ground-work projects for 120 metres seawards, and thereby creates the industrial zone whereas, in the second Section, the constructional work has been limited to the laying out of a highway of 20,000 metres. This is a consequence of what has already been stated, viz., that in this quarter of the port the docks are already in existence in which are centred a very large part of the industry of Vigo, connected intimately with the fishery which it was necessary to respect. The sites not occupied by the latter are devoted to numerous conserving factories, and many of these are being extended towards the other side of the highway on the basis of concessions granted by the proprietary authority.

Dock Approaches

In order to provide the required shelter for the fishing barques in all this part of the harbour, it is proposed to erect a protecting mole, part of the surface of which may be used for coal dumps, with the isolation essential in the case of imports from abroad and which might, with advantage, replace the present transport by lighters.

Once the fishing port has been started on these plans, steps will be directed to providing the details of its equipment as these gradually take form and reality.

In dock No. 1, the first approach route is intended for the ingress of smaller craft, the second for seine-smacks and the third and fourth for motors and motor launches.

In the approach routes 1 and 2 to dock No. 1, a roofed shed has been erected in each route, as also a double connection highway, the main causeway for vehicles circulation, the secondary highways, sanitary installations, etc.

A further advantage to be drawn from the esplanade connecting the mole with the shore walls is that it leaves a spacious circus from which radiate all the streets of the harbour, as well as the interconnecting highways and traffic circulation services.

Dock Structures

On the quay that divides docks 1 and 3 has been erected the central exchange mart, the site being obviously the most favourable one, owing to its proximity to the approach route for motor-vessels engaged in fishing for sardines and parrochas; it is here where, as already stated, is discharged each fish haul on arrival, for which purpose no distributing centre is so well adapted as an exchange.

On the same quay and in close proximity to the exchange, there is erected a double-aisled shed of 120 metres by 20 metres, in which is carried out the initial preparatory work for small exporting firms who do not possess the resources to enable them to rent a site in the sale and preparation building proper.

Within dock No. 3 the first approach route may, when the number of barques exceeds the limit, be utilised for unloading and, when not exceeding the limit, for the victualling and lading of the fish which are transported by sea; the second and third routes are reserved for the provisioning and victualling of the barques, the latter of the two routes comprising the salt stores and coal dumps.

Fishery Port of Vigo—continued

The functions of dock No. 4, reserved as stated, for deep-sea fishing will be as follows: First and second approach routes aligned along the shore wall and the connecting mole are allotted to the unlading of the fish; the small approach route, skirting the sloping section of the third route is reserved for the intake of liquid fuel and ice, and the fourth for similar purposes and also for coaling.

Once the shore wall of dock No. 4, now under construction has been completed, there will become available an ample area which, when reinforced with the other structures in progress will allow of the erection along its entire stretch of an imposing building devoted to the sale and first treatment of the fish, representing a continuation of the railway workshop and, to the rear of this, a wide street leading into the Bouzas highway; there will also remain a small area which will house the shops of the outfitters of fishing equipment and victualling.

In the second approach route fronting the connecting mole there is, in course of erection, a spacious shed for the preparation and sale of the fish, quite independent of the display hall of the first treatment departments; the characteristics and leading features of this erection we shall describe in a succeeding article. In the last ingress route, namely, that along the outer mole, are located the refrigerators and ice factories as also the coal dump.

for the use of barge crews and dock and other auxiliary employees.

Along the entire length of the piers will run a pipe system for the distribution of fresh water for ordinary requirements as well as for drainage and hygienic purposes, the system being extended to embrace the sheds for the washing and pre-treatment of the fish, supplemented beforehand by a supply system for salt water which is the most effective for fish-cleansing purposes.

In order to avoid any damage from the overhead electric conducting cables, these have also been studied and they are to be set up prior to the construction of the paved highways.

There will be, further, installed a telephone service for the interior and luminous call signals.

The CAMPSA organisation will establish tanks for liquid fuel at localities to be specified after taking account of the materials themselves and the sites most suitable.

Prosivision has been made for the supply of the salt-water requisite for the fish-cleaning, the installation comprising three groups of electric motor pumps and one reserve group equipped with a motor of massive steel and each of them with a delivery capacity of 1,350 litres per minute.

It is convenient to have more than one group at disposal, not merely in view of the fluctuations in consumption but also because,

Fig. 4. View of Berbés Dock System so far as the Construction has at Present Advanced.

As regards these refrigerators and ice factories for which an area of 2,300 square metres has been allotted, and also for similar installations which it may be necessary to erect in the harbour, we regarded it as the most suitable course—endorsed by the approval of the Authorities—that the work should be undertaken and carried out by private firms under the supervision of the Harbour Board.

Side by side with all these buildings intended for the first treatment of the fish on the shore margin there are, or will be, constructed railways and highways for motor lorries.

A detailed study has been made of the railway system so as to deal with any difficulties that may arise from the peculiar contour and location of the docks.

The site for the factory and classifying station has been fixed within the shelter of the shore wall of dock No. 4, owing not merely to its easy access to the general communication netway of the harbour and the extensive ground it commands and the elbow room it confers, but also for its nearness to the packing locality, where a large majority of the packages to be invoiced have to be put together.

Running parallel with the sales and packing shed No. 1 extend two high-roads connecting up with the main turnpike system and embracing the classifying centre and the salt, coal and ice stores.

Similarly, there are planned two highways parallel to the protection mole, the one, that next to the approach route, between the derrick emplacements and the other on the outer side. The former will be utilised for lading at times of emergency and for loading trucks which are not destined for transport to other zones, and the latter as a dump for useless material and merchandise to be transported by land and more particularly, the iced fish from the storages.

As many streets as are necessary will be paved and laid out as esplanades, and use will be made in those, for primary transit, of pavement over a substratum of concrete and in the others of tamped surfacings over concrete or pavement over sand. In view of the very great surface to be paved it is incumbent to keep a sharp outlook for any economies that are feasible and consistent with the traffic requirements.

Certain additional terrains still must be mentioned which will be at disposal in future for the station for electric coaches intended

in the event of any one pump being put out of commission, the service as a whole can still operate. In view of this axiomatic principle, there will be installed the reserve group of heavy steel so as to combat also any breakdown in the electric current supply.

With a supply regulator adjusted to 400 cubic metres, allowance is made not only for the hourly fluctuations in consumption but a reserve is also maintained for any unforeseen emergency. This reserve is stored within a cistern of re-inforced concrete at an elevation of 17 metres above the level of the quays, the object being to have an adequate supply available for a satisfactory distribution and also, in the event of fire, to ensure water with a hydraulic head in the hose pipes; it is not profitable to raise the elevation beyond certain limits which would merely augment the construction expenses and the cost of forcing up the water.

The entire installation will have been specified when mention is made of the pipe conduits of a cross-section ample enough to safeguard the service even at times when the consumption reaches its peak.

In the planning of the installation, account has been taken of the higher resistance necessary to combat the action of sea water and of the incrustations of molluscs or other adhesions which the water may carry either in dissolved or suspended form. The cut-offs, valves and those component parts of the pumps as come in contact with the water will be of bronze.

In addition to the three electric, four-ton cranes at the entrance, installed for the loading and unloading of coal and of salt, the harbour will be equipped with electric machines in great numbers, facilitating not merely the unloading of the fish, but also allowing the barges to slow down or temporarily cut out the boilers or bring the motors to a standstill.

(To be continued)

Presentation to Liverpool Dockers.

A presentation has been made by Coast Lines, Ltd., at their Liverpool office to six dock workers in recognition of their services and prompt action, when a fire broke out during loading operations, which, but for their exertions, might have assumed dangerous proportions.

The Hydraulic System of Operation as applied to Dock Machinery

A Survey of Modern Developments and Adaptations

By C. H. NICHOLSON, M.I.E.E., M.I.Mech.E.,
Docks Machinery Engineer, London and North-Eastern Railway.

(Concluded from page 80)

Cranes. (Fig. 9)

With the exception of king post and wall cranes, the hydraulic crane consists essentially of a vertical mast carrying the jib luffing jigger, hoisting jigger, and usually the slewing jigger, supported by a bottom footstep bearing and a vertical roller path at the top of the pedestal, often supplemented by a horizontal roller path.

Fig. 9. (The Hydraulic Eng. Co., Ltd., Chester)

An alternative arrangement is where the whole superstructure revolves around a central post fixed to the pedestal, a horizontal roller path taking the weight of the superstructure, this latter arrangement being invariably adopted for large coaling cranes.

Cranes used for dock purposes are of the following types:—

Wall cranes, attached to the warehouse structure and generally of small capacity (10 cwts. to 2 tons), kingpost cranes used in warehouses, fixed pillar cranes, fixed pedestal cranes, portable pedestal cranes with or without a portal, and heavy coaling cranes.

Any of these types may be provided with a luffing motion, although this is, usually confined to pedestal, portable pedestal, and coaling cranes. Two or three power jiggers are often provided on the hoisting motion in the case of medium and heavy capacity cranes. Portable cranes are provided with hydraulic power by means of either flexible pipes or walking legs consisting of two or more pipes provided with trunnion joints, hydrants being fixed at selected points on both pressure and return mains.

As the machinery for all types of cranes have features which are similar, it is proposed to deal with the various operating motions in a general manner.

The Hoisting motion consists of a single, or multiple, power jigger which for high lift cranes (50-ft. and over) usually has a multiplying power of six. If of the multiple ram type, the selection of the ram is controlled by valves admitting pressure water to the appropriate cylinder, whilst, if of the telescopic type, the larger ram is locked by a mechanical device operated through links by a hand lever. The rams may be provided with bayonets to prevent them coming out of the cylinders, and in addition, stops are provided, limiting the travel of the ram crosshead carrying the multiplying sheaves. In addition, a link motion connected between the crosshead and the valve is usually provided to cut off the pressure before the crosshead engages the stop. The hoisting valve or valves are controlled by hand levers, balanced or pilot valves being used for the larger type of valve, which in the case of the hoisting motion are usually of the mitre type.

The Luffing motion may be operated by a jigger, the luffing rope being attached to the jib in the same manner as in the case of an electric crane. The more usual method, however, is to provide a cylinder and ram at the back of the crane, a bifurcated girder connecting the jib with the luffing ram crosshead which is fitted with rollers running on guides. Level luffing may be obtained by taking the hoisting wire over a sheave, fixed at a definite distance above the jib heel, together with a multiplying arrangement.

The luffing ram is generally of the constant pressure type, consisting of a hollow ram moving inside the luffing cylinder and moving downwards upon a tubular ram which is supplied with pressure water. Upon the luffing cylinder being supplied with pressure, due to the difference in area between the hollow ram and the tubular ram, the hollow ram is forced downwards over the tubular ram, overcoming the pressure in same and luffing the jib inwards. Upon the luffing cylinder being opened to exhaust, the pressure exerted by the water in the tubular ram forces the hollow ram upwards and in luffing the jib outwards. The constant pressure ram thus acts as a return motion, and has the advantage of not consuming pressure water as the tubular ram is, in effect, connected to the pressure main only.

A Tipping motion may be provided for the purpose of tipping wagons (for coaling) by providing the hoisting jigger with two ropes, one being the hoisting rope and the other the tipping rope, which is attached by suitable sling chains to the end of the cradle carrying the wagon. The second rope passes over a sheave attached to the crosshead of a short stroke tipping ram and cylinder. When hoisting normally, both ropes travel at the same speed, the tipping ram being at the bottom of the stroke. To tip

The Hydraulic System of Operation as applied to Dock Machinery—continued

the cradle, the hoisting valve is closed and the tipping valve opened, thus causing the tipping ram to shorten the second rope, and lift the cradle at one end.

Slewing is carried out on all except very large cranes, by means of jiggers, each having a multiplying ratio of approximately two, each jigger slewing the crane in one direction, there being sufficient travel of each motion to overlap the slewing circle. The motion produced by the jigger rams is transmitted by chains or wire ropes to a drum attached to the crane mast. For large coaling and similar cranes (25-50-ton capacity) slewing is carried out by means of hydraulic engine or engines driving a pinion which engages a fixed slewing rack.

Crane Hoisting Speeds should be in proportion to the height of lift and inversely to the load to be lifted.

A suitable formula is: $S = \frac{k.\ H.}{L}$

H being the height of lift in feet.
L the load in tons.
k a constant.
S the speed of lifting in feet per minute

This gives average hoisting speeds of dock general cargo cranes, and agrees very closely with accepted practice. H. as 60 feet and k as 10, crane speeds for various loads are given below:—

Load	*Hoisting Speed*
30 cwts.	400-ft. per min.
3 tons	200 ft. ,, ,,
5 ,, ...	120-ft. ,, ,,
7 ,, ...	85-ft. ,, ,,
10 ,, ...	60-ft. ,, ,,
40 ,, ...	15-ft. ,, ,,
25 ,, ...	24-fr. ,, ,,

It will be realised that there are cranes which do not conform to this formula, but these may be regarded as for special purposes, for instance:—a 25-ton crane with hoisting speed 50-ft. per minute; this crane is a coaling crane, built particuarly for that purpose.

Slewing Speeds are approximately equivalent to 1½ revs. of the crane jib per minute, which with a jib radius of 65-ft. gives the velocity of approximately 600-ft. per minute. The exception being large, capacity cranes and coaling cranes which will have a slewing speed of less than this.

Luffing Speeds vary from 80 to 150-ft. per minute in the case of general cargo cranes, and down to 30-ft. per minute for large coaling cranes.

Wire ropes are used on modern cranes and hence sheaves should be sufficiently large in diameter with respect to rope diameter in order to give reasonable rope life.

Examples of Hydraulic Cranes

	a	*b*	*c*	*d*
Type	Movable Portable	Fixed Pedestal	Movable Portal	Fixed Pedestal
Lifting capacity ...	1½ & 3 tons	5 tons	15/25 tons	25/40 tons
Pressure lbs. per sq. in.	700	800	700	800
Radius...	20/45-ft	20/38-ft.	27/47-ft.	35/45-ft.
Tipping motion ..	Nil	Provided	Provided	Provided
Hoisting motion ...	2 power	single power	2 power	2 power
Ram diameters ...	11½-in.&8½-in.	14-in.	18½in.x3-cyls.	24-in.x3-cyls.
Stroke	12-ft. 6-in.	11-ft.	12-ft.	12-ft.
Multiplying power	6:1	6:1	6:1	6:1
Luffing Motion ...	Level	Non-level	Non-level	Non-level
Ram diameters ...	7-in. & 3-in. const. press.	8⅝-in. & 3-in. const. press.	10-in. & 3-in. const. press.	9-in. x 2 & const. press.
Stroke	7-ft. 6-in.	9-ft.	2-ft. 6-in.	10-ft.
Multiplying power	direct acting	direct acting	4:1	direct acting
Slewing Motion:				
Ram diameters ...	9½-in.	9-in.	—	—
Stroke	9-ft.	7-ft. 9-in.	—	—
Multiplying power	2:1	4:1	—	—
Hydraulic engine ...	—	—	3-cyl.	3-cyl.
Speeds:				
Hoisting	240 f.p.m.	400 f.p.m.	50 f.p.m.	60 f.p.m.
Luffing	150 f.p.m.	80 f.p.m.	30 f.p.m.	30 f.p.m.
Slewing (maximum)	425 f.p.m.	400 f.p.m.	300 f.p.m.	360 f.p.m.
Hoisting Motion:				
Efficiency at full load	60%	55.4%	60%	50%
Efficiency at light load	55%	—	54%	46.8%

(*a*) General cargo crane.
(*b*) High-speed coaling crane utilising 2 skips each of 2½ tons gross weight.
(*c and d*) Coaling cranes lifting wagon in cradle.

All the above cranes have an overload capacity of 25% above full load.

Tipping Platforms. For the purpose of delivering coal, coke, etc., to hoppers feeding coal conveyors, coal skips operated by cranes, gravity chutes by means of end door wagons, it is necessary to tip the wagon from one end, the material being thus ejected into the hopper from the door fitted at the opposite end to that which is lifted into the hopper. The usual manner of carrying out this operation is the provision of a hinged platform fitted with rails and restraining hooks or horns which hold either the wagon axle or wheels, the whole platform being elevated at an angle of about 55 degrees by means of a direct acting hydraulic cylinder and ram controlled by mitre valve and hand lever.

In order to obviate the use of a turntable to ensure the end door being in the correct position, tipping platforms are often installed in duplicate, with a receiving hopper provided between the two platforms.

Where it is necessary to prevent breakage of coal due to this striking the rails across the hopper (which are for the purpose of conveying the empty wagon across the hopper to the empty sidings) these are fixed to a frame which is hinged at the bottom and allows the rails to move outward when the wagon is tipped, this being accomplished by the tipping ram lifting a counter-balance weight, which allows the hinged frame counter-weight to move the hinged structure in an outward direction, the reverse taking place as the ram is lowered.

Examples of Tipping Platforms

	a	*b*
Type	Single end	Double end
Capacity	30 tons	30 tons
Lifting speed	35-ft. per min.	35-ft. per min.
Ram diameter	10½-in	11½-in.
Stroke of ram	10-ft 6-in.	11-ft. 6-in.
Rail opening device	Counterweight	Separate hydraulic ram
Hydraulic pressure lbs. per sq. in.	700	700
Efficiency at maximum load ...	75%	75%

COAL HOISTS

One of the most usual methods of shipping coal in this country is by means of hydraulically operated coal hoists. A coal hoist is essentially of a steel structure, consisting of four main vertical girders suitably braced and provided with a movable platform for the purpose of lifting wagons from ground level to the required height necessary to deliver coal in to the hatches of the vessel.

The platform is guided througout the distance travelled by vertical guide bars and suspended by wire ropes, the movement of the platform being brought about by means of a hydraulic jigger attached to the side of the hoist structure.

Coal Hoists may also be of the " direct acting " type, in which the lifting ram crosshead is connected direct to the hoisting platform, entailing a ram length equal to the height of lift required. The ram may be of the telescopic double-power type and the weight of the hoist platform may be partially balanced by counter weight, or hydraulically by constant pressure rams, and as an alternative two or three lifting rams of different diameters may be utilised. This type, however, is now almost obsolete.

Lifting machinery for a modern coal hoist comprises inverted cylinders and rams arranged as jiggers with the object of reducing the length of the ram and increasing the diameter. The jigger ropes are taken over the sheaves at the top of the hoist structure and anchored to the hoisting platform by adjustable shackles, there usually being four ropes.

The weight of the platform is partially balanced by means of counter-weights, or constant pressure rams, the main rams and counter-weight guides being fixed on the side of the hoist structure.

In order to deliver the coal from the wagon the platform is provided with a hinged frame, the unhinged end of which can be elevated by means of tipping rams in order to give an angle of approximately 50 degrees between the frame and the horizontal, this being the method of dealing with wagons provided with end doors.

The Hydraulic System of Operation as applied to Dock Machinery—continued

In order to deal with bottom-door wagons, a hopper and chute is provided under the tipping platforms. A chute having a bearing at the heel end to enable it to be moved approximately 15 degrees on either side of the centre line of the hoist (the bearing carried by bracket engaging vertical guide bars), is provided for the purpose of transferring coal from either the wagon end door or from the hopper to the hatchway of the vessel. The bracket is fitted with pawls, which engage in a vertical rack, enabling the heel end of the chute to be locked in any desired position.

The nose or outer end of the chute is supported by wire ropes or chains passing over sheaves at the top of the hoist structure, and vertical movement of the chute nose is carried out by means of either a jigger or hydraulic engine. Manually, or hydraulically, operated doors fitted at the nose end of the chute control the flow of coal from the chute to the hatch. The chute is positioned either by hydraulic engines or operated directly by jiggers.

It is thus possible to lift the wagon to any desired height for shipment, adjust the heel end of the chute to meet this height, and also adjust the nose height to give any desired angle of inclination to the chute. The chute itself is often made extensible (or telescopic) and thus may be operated by small hydraulic cylinder and ram fitted on the underside of the chute.

The method of operation is as follows:—

The heel of the chute is set and locked to the required delivery height and the nose end is also adjusted to align with the hatch, the angle of inclination being dependent upon the class of coal to be delivered, i.e., if dry large coal, this angle is less than for small wet coal.

The loaded wagon is then drawn on to the hoist platform at ground level, being actually carried by the rails fitted to the hinged frame. The platform then raises the wagon to the required delivery height, and if an end-door wagon is being used, the hinged frame is lifted at one end, the coal being ejected from the wagon into the delivery chute. In the case of bottom-door wagons, the frame is not lifted, the coal being transferred from the wagon through the bottom doors into the hopper, and thence to the delivery chute.

The platform carrying the empty wagon is then lowered and the wagon is drawn on to the rails leading to the empty wagon reception sidings. In order that the empty wagons may run into the sidings by gravity, the rails leading to these are generally elevated above ground level, so that after having dealt with the empty wagon, the hoist platform is returned empty to ground level in readiness to deal with the next loaded wagon.

Coal Hoists are generally designed to be capable of loading to vessel from 500-800 tons of coal per hour under normal conditions, such as the shipment of dry average sized coal. Capstans are provided for the purpose of delivering and removing wagons to and from the hoist.

All motions may be operated from a central driving cabin, and in view of the large capacity of the hoisting cylinders, and relatively high speeds approximating 180 feet per minute, large operating valves of the mitre type are necessary, and in order to reduce the manual effort required, these are invariably of either the balanced type or pilot-operated type.

Examples of Coal Hoists

	a	*b*	*c*
Type	Rope operated	Direct acting	Rope operated
Capacity	About 20/30 tons	15 tons	30 tons
Maximum delivery height	62-ft.	41-ft.	71-ft.
Speed	180 f.p.m.	120 f.p.m.	180 f.p.m.
Hydraulic pressure	700 lbs. per sq. in.	750 lbs. per sq. in.	750 lbs per sq. in.
Hoisting ram diam.	15½-in.	8½-in.	17½-in.
Stroke	31-ft.	41-ft.	35-ft. 6-in.
Number of rams ...	2	2	1
Multiplying power	2 1	direct acting	2:1
Auxily. ram diam.	7½-in.	—	10½-in.
Auxily. ram stroke	31-ft.	—	35-ft. 6-in.
Number of rams ..	2	—	1
Multiplying power	2:1	—	2:1
Tipping Motion ...	Ram	Ram	Ram
Method of counter-balance	constant pressure ram	constant pressure ram	constant pressure ram
Chute nose operated by	Hydraulic engine	Ram	Hydraulic engine
Efficiency at full load	47.7%	52.6%	64.4%

Of the above hoists, *a* and *c* are capable of dealing with 10, 15 and 20 ton wagons, and have auxiliary rams which are brought into use when lifting 20 ton wagons, and in this connection the rating of the wagons is the approximate nett load carried.

Capstans. (Fig. 10)

Capstans may be direct acting, gear driven, fixed head or free head. A hydraulic engine controlled by a counter weighted valve operated by a foot treadle, being utilised for driving the capstan head.

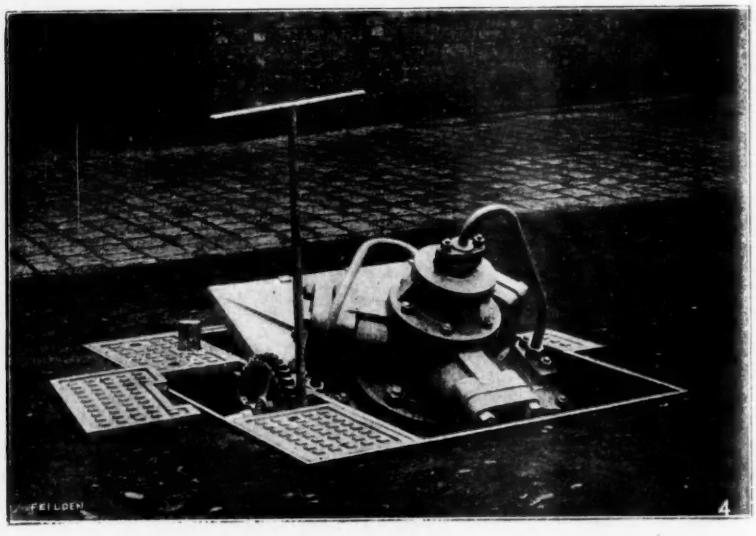


Fig. 10. (The Hydraulic Eng. Co., Ltd., Chester)

In the case of the direct acting type, the capstan head is directly coupled to the engine crankshaft, and this type is used for all purposes, and may be designed to give a direct pull of from two to three tons at the periphery of the head.

The method of driving the free head capstan is the same except manually operated clutch between the engine crankshaft and the capstan head is provided.

Free head capstans are used for straight haulage, and under these conditions give rope economy by the use of a wire rope permanently attached to the Capstan Head. To pay out the rope the capstan head is de-clutched from the hydraulic engine crankshaft; this type however, is not suitable for turntable work, a fixed head capstan and a manila rope being used in this case.

Where a large tractive effort at low speeds is required, and generally in the case of capstans over about three tons capacity, gearing is provided between the hydraulic engine crankshaft and the capstan head.

Examples of Hydraulic Capstans

	a	*b*	*c*
Capacity	1 ton	2 tons	5 ton
Type	Direct drive	Direct drive	Gear drive
Hydraulic pressure...	750 lbs. per sq. in.	750 lbs. per sq. in.	750 lbs. per sq. in.
Ram speed in f.p.m	147	102	51
Peripheral speed of capstan head f.p.m.	250	200	60
Efficiency at full load	46%	62%	55%

DOCK GATE MACHINERY

For the purpose of opening and closing the gates at Dock entrances, the operating machinery is installed in chambers below ground at each of the dock entrance adjacent to the gates and controlled by manually operated valves.

The Hydraulic System of Operation as applied to Dock Machinery—continued

There are three general types of dock gate operating machinery, these being briefly:—

(a) winch and chain.
(b) jigger and chain.
(c) direct acting ram.

The first type consists of hydraulic engines driving geared winches through clutches, one winch for the purpose of closing the half gate and one to open same being provided at each side of the Dock entrance, thus four winches are necessary for one pair of gates.

In order to close the gates, the opening winches are declutched from their driving engines, and the closing engines are clutched into the winches and supplied with pressure by means of manually operated valves, the reverse procedure taking place to open the gates. This type is now almost obsolete.

Jigger operated dock gate machinery operates in a somewhat similar manner, there being four jiggers per pair of gates, i.e., two for opening each pair of gates and two for closing. These jiggers may be either of the double acting type having a packed ram or piston or may be single acting (simple displacement ram). If the latter, in order to return the closing ram, this is provided with a constant pressure ram, or alternatively, an auxiliary ram.

To open the gates manually operated valves admit pressure water to the two opening jiggers, and at the same time open the closing jiggers to exhaust. If auxiliary rams are fitted, valves admitting pressure water to these may be arranged for simultaneous operation.

Direct operation of dock gates may be carried by two double acting rams one at each side of the dock entrance, the ram cross-heads being provided with a trunion which transmits the movement of the ram to a pressure bar fixed to the half gate.

Manually operated valves admitting pressure water to the back ends of the cylinders, whilst the front ends are to exhaust cause the ram to move outwards and this closes the gates; the reverse operation causes opening of the gates. If single acting displacement rams are utilised two such rams in tandem, one for the purpose of closing and one for opening are required for each half gate.

Hydraulically Operated Sluice Valves.

Where sluice valves are of such size that the power required is too great for manual operation, these can be very conveniently opened and closed hydraulically, a double acting hydraulic ram and cylinder being mounted directly up on the top of the valve. The method of operation is as follows:—

When pressure, controlled by suitable hydraulic valve which may be of the slide valve type is admitted to the bottom end of the cylinder, the sluice valve is lifted, the reverse taking place when pressure is admitted to the top of the cylinder.

A typical example is a 42-in. diameter sluice valve operated by hydraulic cylinder of 6-in. diameter, the hydraulic pressure being 750 lbs. per square inch, and the pressure against the sluice valve being equivalent to a 40-ft. head. A similar arrangement is used for the purpose of opening and closing the sluice gates installed at dock entrances, docks and graving dock culverts.

Acknowledgments

The writer is indebted to E. Thompson, Esq., O.B.E., M.I.Mech.E., Chief Mechanical Engineer, London and North Eastern Railway Company, for permission to publish data referring to the L.N.E.R. Dock system, also Messrs. Mather & Platt, Ltd., Manchester, Hydraulic Engineering Co., Ltd., Chester, and Messrs. J. Walker & Co., Ltd., Woking, for the loan of blocks and use of technical data which they have kindly provided.

Lengthening of Swedish Graving Docks.

Two naval graving docks in Sweden, one at Stockholm and the other at Karlscrona, are to be lengthened, in the first case to 183.6 metres, at an estimated cost of 1,220,000 kroner, and in the second case to 185 metres, at an estimated cost of 573,000 kroner. The extensions are for the purpose of accommodating new cruisers.

Notable Port Personalities

XLIV—The Rt. Hon. Lord Ammon

A Londoner by birth, the **Rt. Hon. Charles G. Ammon,** D.L., J.P., L.C.C., first Baron Ammon of Camberwell, and Chairman of the National Dock Labour Corporation, served for 24 years in the Post Office, which he entered as a telegraph messenger, eventually becoming Editor of *The Post*, the organ of the Fawcett Association, which is the Postal Sorters' trade union, and later Chairman of the Association. He left the Post Office in 1916 to become Secretary

LORD AMMON.

of the Docks, Wharves and Shipping Staffs Association, now merged in the Transport and General Workers' Federation, and afterwards Organising Secretary of the Civil Service Association, now merged in the Civil Service Clerical Association. On the formation of the Union of Post office workers, he was appointed Organising Secretary, a position from which he retired some years ago.

In 1919 he was elected to the London County Council as a representative for North Camberwell; he is still a member and is chairman of its Parliamentary Committee. He was Chairman of the Council during 1941-42.

He entered Parliament in February, 1922, as a Labour member, being the first Post Office employee to become an M.P. He was appointed Whip of the Party in 1923, and Parliamentary Secretary to the Admiralty in both Labour Governments, 1924 and 1929-31. He was raised to the Peerage in the present year.

Lord Ammon is an Alderman of the Camberwell Borough Council, and Chairman of its Assessment Committee. He has lately been appointed Chairman of the National Dock Labour Corporation, Limited, in which capacity he has been making a tour of the ports in the South Wales and River Tyne areas to see the working of the organisation.

Death of Harbour Master.

The death has occurred at the age of 59 of Captain J. M. Munro, harbourmaster at the Port of Ayr for the past 8 years.

The Co-ordination of Transport Services

South African Port and Railway Affiliation

By G. LIDDIARD, J.P.

Rationalisation of Transport

Transportation, the industry upon which all other industries depend, is the most extensive of all spheres of human activity, and the solution of the problems of efficient and economical transport is of the utmost importance. In most countries there is a strong tendency in the direction of co-ordinating all forms of transport, in order to reduce costs and increase efficiency, and South Africa has been in the fore-rank of the countries endeavouring to attain this very desirable object.

The control and organisation of the railways and harbours and other transport services in South Africa under one Administration are unique in the world of transport. They are the first to have been completely rationalised, using that term in its broadest and highest sense—the co-ordination and utilisation of the transport services in the best interest of the nation as a whole. The railways and harbours and road motor services on which some £197,000,000 is invested are not owned by shareholders all over the world, but belong to the people, and are the nation's greatest asset, being operated for service and not for profit.

Co-ordination of Ports and Railways

Ports are the connecting links between land and sea transport, and in no other country, except perhaps Soviet Russia, are the whole of the harbours and adjunctive services amalgamated with the railways into one state-owned system, enabling the fullest possible co-ordination in the working of the railways and port terminals. In a recent authoritative publication dealing with transportation in the United States it is asserted that co-ordination between the ports and railways is one of the most serious needs at American ports.

Prior to Union there was a competitive struggle between the ports of the Cape Colony and of Natal to snatch from each other every ton of goods that could be snatched. There was continual friction and disagreement between each of the railways owned separately by each of the four colonies. In fact a beggar-my-neighbour policy existed which was mutually destructive to the interests of all concerned. With Union achieved, the railways and harbours pooled their resources, which has proved to be a far-sighted policy.

At the time of the Union, advantage was taken of the great opportunity that presented itself of bringing the railways and harbours under one unified control, thus combining all traffic operations at the ports and on the railways. Existing systems in other countries were not slavishly followed under the belief that they are necessarily suitable for South Africa because they are in operation elsewhere. It was realised that the problem at the ports is a railway as well as a shipping problem, the three links of transportation being railways—port—ship and vice versa. Railway and port operations being under one control traffic can, of course, be more promptly and economically dealt with than when ports and railways are separate organisations, each bent upon studying its own interests without regard to the traffic requirements as a whole.

The co-ordinated system of railway and port terminal facilities has been proved to be sound in theory and in practice, and it can be definitely stated that the dues and charges at South African ports compare very favourably indeed with those at similar ports elsewhere.

Difference between Union and Overseas Ports.

The difference between the systems at Union ports and overseas ports is fundamental. Freight has to be transferred from ship to railways, or to road vehicles for local delivery; from wharves to ships and from one ship to another. For these services special equipment is required, including wharves and wharf sheds, railway sidings, trucks and road vehicles, tugs and lighters, cranes, coaling appliances, grain elevators, and many other facilities. All of these at most of the ports in other countries are variously owned and operated by dock companies, railway and steamship companies, public trusts, and numerous commercial and industrial concerns; whereas at Union and South West African harbours all port facilities are provided by the one Administration which undertakes all harbour services.

As soon as a vessel comes within the defined area at each harbour nearly all services to the ship are undertaken by the port authorities, and her cargo is looked after by the Railways and Harbours Department from the time it is released from the ship's slings until it reaches its destination either by rail or road. The problem presented is not complicated by a multiplicity of authorities and conflicting interests. The railway terminal facilities and port operations being under one control results in smooth and economical working, which it is impossible to achieve where there is divided control.

The various services rendered include the provision of lighthouses and other aids to navigation, pilotage, tug services, salvage operations, berthing and unberthing of ships, dry-docking facilities, landing and delivery, collection and shipping of cargo, cartage, construction and maintenance of harbour works, dredging, licensing of pilots, inspection and licensing of harbour craft, and licensing of various agents, maintenance and operation of life-saving equipment.

Rapid Despatch of Ships

There is no economy like the economy of despatch where ships are concerned, and the combined railway and harbour working provides the utmost facilities for the expeditious despatch of both ships and cargo, our ports being most economical for ships in both time and money.

The combined railway, harbour and cartage services have proved to be highly efficient, and co-ordination is just as essential in other correlated transport services which are mutually inter-dependent.

In regard to trassport problems, the Union is in a most favourable position, because the national system of railway transport, with its widespread organisation is specially favourable for combining all forms of transport in the best interests of the country.

Road Motor Services

One of the most important branches of co-ordinated transport is the operation of road motor services in conjunction with the railways. The Administration, at a very early stage, realised the possibilities of the new form of transport, its first motor service being inaugurated between Bot River and Hermanus as far back as the year 1912; and as the result of the introduction of the many services in rural areas, within a comparatively short period, its route mileage by road transport exceeded that of the railways. The numerous motor transport services operated by the Administration open up remote parts of the country and, therefore, must stimulate the extension of trade, for trade follows transport. They encourage the increase of farm production by enabling the marketing of small as well as large quantities of produce, and distribution generally is facilitated.

From the time when the Cape Town—Wellington and Salt River—Wynberg lines were taken over by the Cape Government in 1873 and 1876 respectively, and the Durban-Point and Durban-Umgeni lines by the Natal Government in 1877, the policy of state control of railways has been consistently adhered to, and unregulated or wasteful competition which would break down the policy of state control would be inimical to the proper co-ordination of all forms of public transport.

Transportation in Soviet Russia

The remarkable achievements of Soviet Russia prompts one to allude to what has been accomplished in so short a period of time. After the revolution all transport services were in a chaotic state, and the most urgent necessity was for improved transport facilities throughout the vast Russian territories. It was a colossal task and the Soviet Government very wisely adopted the system of unifying all forms of transport, by rail, river, road, sea and air, and at the ports in one single transport system.

South African Ministry of Transport

The inauguration of the Ministry of Transport in South Africa seems to be the consummation of the policy consistently pursued since the date of Union of co-ordinating all forms of public transport, as far as practicable, and will no doubt assist greatly in the growth of the industry, agriculture and the general development of the national economy, which will make increasing demands on the transport services of the country.

Notes of the Month

Reconditioning of Aberdeenshire Harbours.

Aberdeen County Council has appointed a committee to report on the reconditioning of small fishery harbours within the county area.

New River Tyne Commissioners.

Councillor William McKeag and George H. Graham have been appointed representatives of Newcastle Corporation on the Tyne Improvement Commission in place of Alderman Sir Arthur Lambert and Alderman E. Gibbin who have recently retired.

Improvements at Mobile.

Over half a million dollars is to be expended on repairs and improvements at the Port of Mobile, Alabama, U.S.A. The amount was sanctioned at a meeting of the State Docks Advisory Board early in May, following a conference with the State Governor.

Institute of Transport.

The inaugural meeting of the 1944-45 Session, the Silver Jubilee Session of the Institute, will be held on Tuesday, October 3rd, 1944, at 5.30 p.m. in the Lecture Theatre of the Institution of Electrical Engineers, Savoy Place, London, W.C.2, when Mr. Robert Kelso will deliver his Presidential Address.

Harbour Appointment at Ipswich.

Captain John MacRae, harbourmaster at Paisley, has been appointed assistant harbourmaster and dock superintendent to the Ipswich Dock Commission. The appointment dates from September 1st.

Lossiemouth Harbour Extension.

The urgent need for an extension of Lossiemouth harbour in order to cope with the development of the seine net fishing industry, was impressed upon Northern M.P.'s, during their visit to the port with other members of the White Fish and Shell Fish Committee appointed by the Scottish Council of Industry.

Retirement of Port Official.

The retirement from the position of chief warehouse manager of the Mersey Docks and Harbour Board is announced of Alderman H. P. Long whose connection with the Board has lasted since 1893. He became chief warehouse manager in 1930, after being assistant to his predecessor. For nine years he had held appointments with the Port of London Authority.

Blyth Dry Docks Undertaking.

The announcement is made that the management of the Blyth Dry Docks and Shipbuilding Co., Ltd., has changed hands. Sir Arthur Sutherland, the former chairman, has resigned and new directors have been appointed, including the present general manager, Mr. William Turnbull. Mr. Alan Greig retains the post of Secretary.

Death of Dry Dock Proprietor.

The death took place towards the end of July of Colonel George Rollo, C.M.G., D.S.O., vice-chairman and managing director of Messrs. Grayson, Rolls and Clover Docks, Ltd., a well-known firm of dry dock proprietors and ship repairers on Merseyside. Colonel Rolls was 62 years of age and had been in ill-health for over two years. He had had a distinguished military career.

Whalsay Harbour Scheme.

A harbour scheme for the island of Whalsay, Shetland, estimated to cost £93,600 has been remitted by Zetland County Council to the District Council and the newly formed Whalsay Development Council for consideration. The scheme provides for a pier 300 feet long and a breakwater, with land sheds and roads.

American Association of Port Authorities.

The 1944 Annual Convention of the American Association of Port Authorities will be held from October 10th to 13th in New York City, U.S.A., the Port of New York Authority acting as hosts.

Proposed Terminal at New Zealand Port.

A movement is on foot to provide Northcote, New Zealand, with a modern ferry terminal, including two jetties and a vehicular landing place. The scheme provides for parking areas and the construction of two breakwaters to protect and enclose the jetties.

Galway Harbour Board.

Galway Harbour Board decided at a recent meeting to approach Galway Corporation, Galway County Council and the representatives of Galway in the Dail regarding the revival of the Galway Air Development Committee. It was felt that the committee could then place before the Eireann Government the case for the construction of an airport at Galway.

Whaling Facilities at Chilian Port.

A modern whaling station and conversion plant are said to be nearing completion at the Port of Quintay, Chile. Shore installations include piers, self-contained power plants operated by Diesel engines, processing rooms, warehouses, administrative offices and living quarters for employees.

Death of Former Port Manager.

The death has been announced at New Orleans of Mr. John McKay, who was general manager of the Dock Board from December, 1929 till 1940. He also served four terms as president of the local Board of Trade, or, in English terms, the Chamber of Commerce.

Port of New Orleans and Marine Growths.

" One of the many advantages to vessels using the Port of New Orleans," states the *New Orleans Port Record*, June, 1944 issue, " is that barnacles, which have accumulated on the hull, die and drop off after the vessel has been in port several days, because these parasites cannot live in fresh water. This represents a saving of thousands of dollars annually to steamship operators, for it saves them the expense of dry-docking their ships to remove this marine growth."

Proposed Developments at Dover Harbour.

The Post-War Development Advisory Committee at Dover have advised an extension of the harbour accommodation. To increase the commerce of the port, the report states that new berths and facilities must be provided. The existing sea-front and foreshore would not be interfered with, if the extension works were carried out at the eastern end of the harbour.

Cape Town New Graving Dock.

It is confidently expected that the new graving dock at Cape Town—one of the largest in the world and exceeding the new Sydney dock in length by 60 feet—will be in commission some time next year. The dimensions of the Cape Town Dock are: length: 1,248-ft.; width of entrance, 148-ft.; depth of water at entrance: 40-ft. at L.W.O.S.T. and 46-ft. at high water.

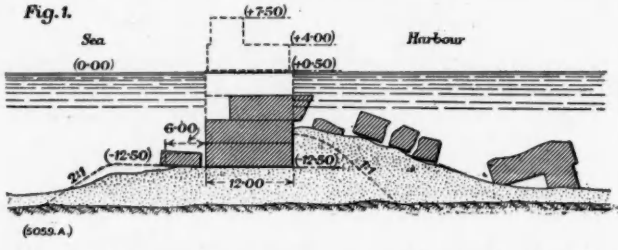
Alleged Defects at Tyne Dock Entrance.

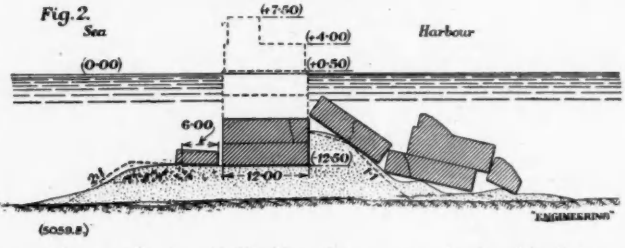
At a recent meeting the Tyne Improvement Commissioners approved certain steps taken by the sub-committee relating to the entrance to one of the Commissioners' docks. The matter is to be given further consideration with a view to laying before the Commissioners proposals having as their object the removal of causes of damage to the dock entrance and to shipping, possibly by a modification of the entrance.

The Stability of Vertical-Wall Breakwaters*

A Consideration of Recent Failures with the Results of Tests on Models

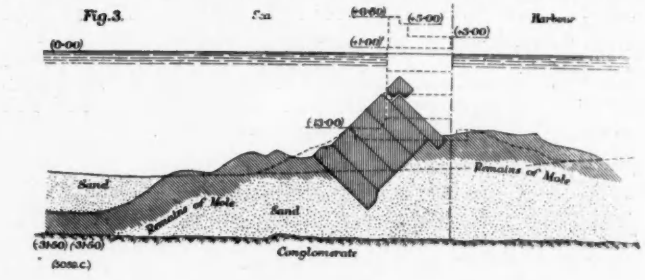
IT will be within the recollection of readers of *Engineering*† that in January, 1935, an account was given of the disastrous experience at the port of Algiers in the preceding February, when a length of 401 m. of newly-constructed breakwater collapsed during a storm of exceptional severity. In the article in question a reference was also made to the storm of the previous year which had caused the destruction of 700 lineal m. of a similar work at the port of Catania. Both these breakwaters were constructed of the same type, viz., a vertical wall of superimposed blocks based on a foundation of rubble stone, and the double disaster, following only a few years after a catastrophe of the same nature at Antofagasta, Chile, has naturally caused a certain amount of uneasiness and misgiving as to the stability and trustworthiness of such vertical-wall breakwaters, particularly in Italy, where a considerable number of harbours are protected by works of this kind. The subject was reviewed at length in the summer of 1935 in a lecture at the Institution of Civil Engineers by Professor E. Coen Cagli, of the School of Engineering at Rome, and the matter being so important from a harbour engineering point of view, it will be advantageous to consider the conditions of stability of such breakwaters in the light of certain experimental researches on small-scale models, the results of which Professor Cagli described in his lecture. Progessor Cagli, it may be added, was chiefly responsible for the introduction into Italy of the vertical wall breakwater, which he recommended for adoption after an official visit to Great Britain in 1896, during which he had the opportunity of studying the breakwaters at Dover, Sunderland, Tynemouth, Aberdeen, Peterhead and Wick.

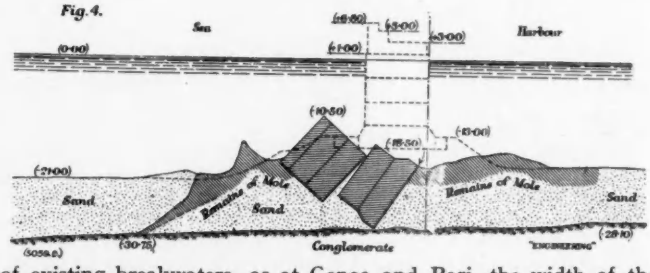




It should be recalled that although the breakwaters at Catania and Algiers were of similar design and calibre, the failures were brought about in entirely different ways, due to an essential difference in construction. Both breakwaters were built of massive concrete blocks of cyclopean proportions, in the case of Catania, 12 m. long by 4 m. by 3.25 m.; and in the case of Algiers, 11 m. long by about 4 m. square. These blocks, weighing, respectively, 320 tons and 400 tons, were set, as headers, transversely in the moles, their ends forming the inner and outer faces of the wall, but whereas the blocks at Catania were simply superimposed without bedding or bonding, those at Algiers were provided with internal hollow shafts or wells, which, on completion of the wall to full height, were filled with concrete, reinforced by steel bars, so as to form a coherent structure from base to coping. As might be not altogether unexpected under such conditions, the mole at Catania failed by the sliding of the blocks over one another in successive courses as indicated in Figs. 1 and 2, which give typical sections, whereas the mole at Algiers collapsed as a whole i.e., in intact vertical sections before fracturing and disintegrating, collapse being brought about by the undermining of the rubble mound through wave action and the erosion of a deep trench in the soft sea floor, which consists of sand and mud, at the foot of the wall. The conditions produced at Algiers are shown by the typical diagrams, Figs. 3 and 4.

As was urged by Professor Cagli in his lecture, there is abundant justification for regarding neither of these experiences as involving any condemnation of the principle of the vertical-wall breakwater. Had the blocks at Catania been closely bonded and interconnected, and had the foundation mound at Algiers been better protected from undermining and erosion, probably neither of the disasters would have occurred; at any rate, the works would in all likelihood have survived with damage of a not irreparable character, notwithstanding the fact that the storms they experienced were of unprecedented violence and generated waves of a magnitude not contemplated when the breakwaters were designed.* With the exception of Catania, all the chief breakwaters in Italian waters, built as vertical walls with cyclopean blocks, as well as those of lesser importance have successfully withstood the onslaught of the heaviest seas to which they have been subjected. The incidents at Catania and Algiers have, indeed, served to indicate certain defects which can be remedied without materially affecting the accepted type. It is realised that the depth of water to the foot of the wall needs to be greater in order to safeguard the rubble mound, and in the case of existing breakwaters, as at Genoa and Bari, the width of the berm or ledge at the top of the mound is being increased and the side slopes less steeply inclined.





*This article, by the Editor, was contributed to *Engineering* of February 7th and 12st, 1936. By permission of the Editors of that Journal it is reproduced here as an introduction to a further article on the subject by a well-known contributor which will follow in due course.

†Vide Vol. cxxxix, page 27.

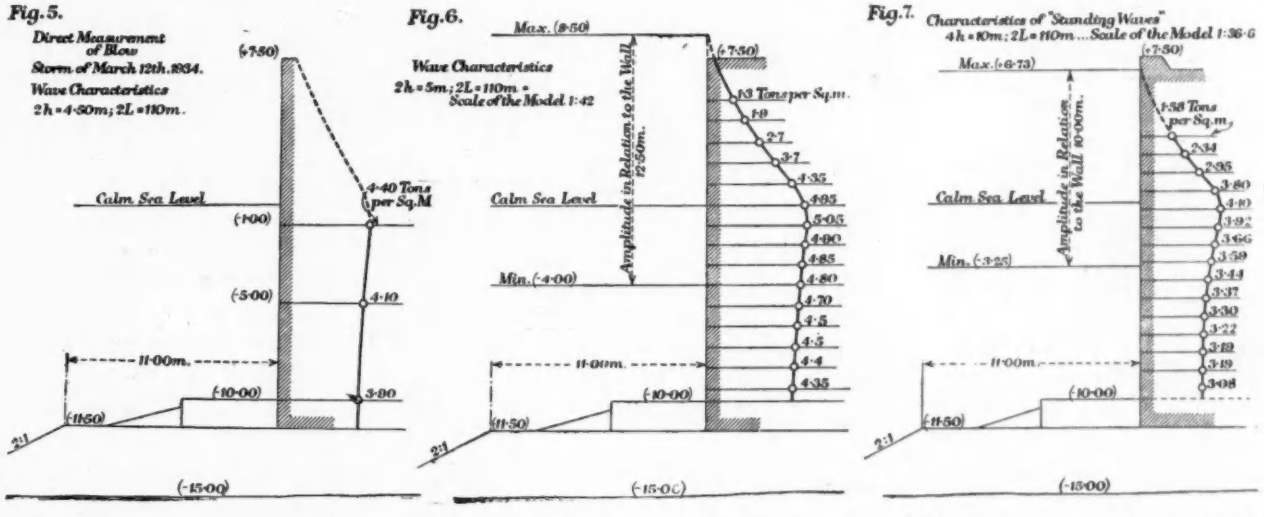
*At Catania the waves in the open had a height of 7½ m. and a length of 230 m.; at Algiers, they had a height of 9 m. and a length of 300 m.

Stability of Vertical Wall Breakwaters—continued

Hitherto, there has been a considerable degree of assumption in calculating the effects of wave pressures on breakwaters for lack of adequate data with regard to wave action, particularly as regards impact on a vertical wall and the intensity of pressure at different levels. The matter came up for discussion at the XIVth International Congress of Navigation, held at Cairo in 1926, and a special committee was then appointed to investigate the subject. In conformity therewith, a series of observations has been carried out at the port of Genoa by means of the installation of a hollow block in the outer, or Principe Umberto, mole, containing apparatus for recording mechanically on the spot piezometric readings of wave pressure at various altitudes and depths, and also for transmitting them electrically to an internal station for record in the form of continuous "oscillograms," as mentioned in the article in *Engineering* previously referred to. These oscillograms, described by Dr.-Ing. Salvatore Levi in *L'Ingegnere* of August 1st, 1934, are of an exceedingly interesting character and furnish valuable information respecting the range and extent of wave pressures.

In extension of the observations made in the first part of this article, and for the purpose of analysing more closely the circumstances which led to the disasters at Catania and Algiers, Professor Cagli, in collaboration with Professor Stucky, of the University of Lausanne, has been carrying out a series of experiments with small-scale models in the hydralic laboratory at that University,the results of which were summarised by Professor Cagli in his lecture in the following terms:

(1) The perfect agreement of the actual observations recorded at Genoa with the results of the corresponding tests on the model of the Principe Umberto mole, as shown in Figs. 5, 6 and 7, indicates, on the one hand, that the method of research by means of tests on small-scale models, based on the law of similarity, is strictly applicable to the study of wave forces and, on the other hand, in opposition to the opinion held by some writers, that oscillating waves, in violent storms at any rate are not converted by reason of their reflection at a vertical wall into actual "standing waves," but maintain their essential characteristics as trochoidal waves with orbital, though modified, movement,



The results so far recorded at Genoa in the case of waves striking the breakwater at right angles, but in no instance attaining the possible maximum length, nor exceeding 5 m. in height, were reported by Professor Cagli in his lecture to show:

(1) That the horizontal stresses (that is, excess of positive or negative pressure, according as it is either landwards or seawards, compared with the calm water level) exerted by oscillating waves reach a positive maximum value, generally a little below the level of smooth sea.

(2) That the positive maximum stress is very nearly equal in all cases to the hydrostatic pressure due to the height (2h) of the wave impinging against the wall.

(3) That this same stress diminishes rapidly above smooth sea level, even if the breakwater parapet is surmounted by the waves, the crests of which usually surpass, often considerably, the theoretical height corresponding to an amplitude of oscillation double the height of the incident wave: this fact alone proving, at the outset, that the pressures exerted by waves are not of a simple static nature, but are a combination of static pressure and dynamic force.

(4) That the positive maximum force diminishes, on the other hand, below smooth sea level, the more slowly as the ratio of height to length of the wave decreases. In the case of waves of ordinary proportions, the force is reduced at the foot of the wall to a value which always exceeds one half the maximum, while it remains sensibly uniform and equal to the maximum from the sea surface to the foot of the wall in the case of waves which are exceptionally long as compared with their height.

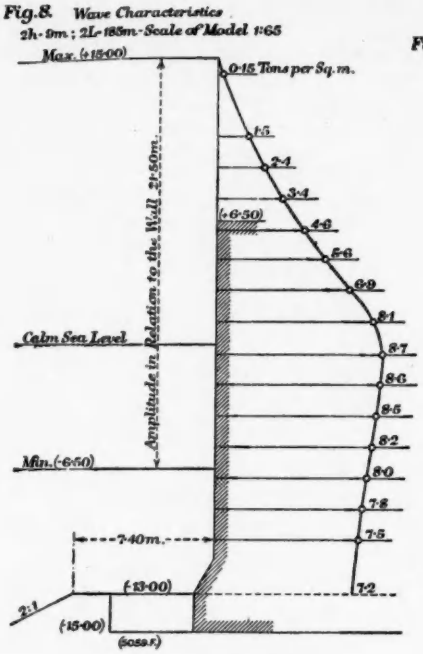
(5) That the maximum negative strees below the trough of the wave in contact with the wall is sensibly equal at all levels to the corresponding positive stress.

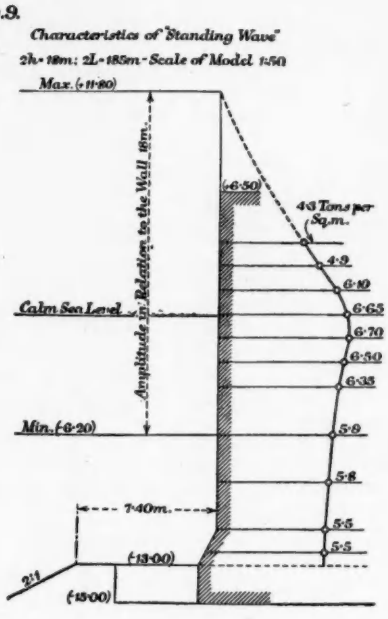
and they exert pressures that notably exceed those which would be produced by an actual standing wave* engendered by the same trochoidal wave. This is clearly shown by the diagrams in Figs. 6 and 7, from which it has been computed that the total force exerted in the case of the mole at Genoa by an ordinary wave 5 m. high and 110 m. long (Fig. 6) exceeds by 26 per cent, the total force that would be exerted by a standing wave (Fig. 7) engendered by the same ordinary wave and having therefore the same length but twice the height.

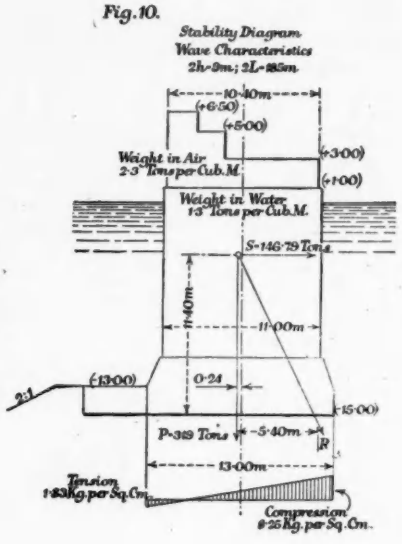
(2) The tests on small-scale models of the Mustapha Jetty at Algiers have shown, as represented in Figs. 8, 9 and 10, that under the assault of the terrific storm of February 3rd, 1934, with waves 9 m. high and 185 m. long in the immediate vicinity of the work, the wall experienced total forces rising to 147 tons per lineal metre of structure, greater by 35 per cent. than that which would be exerted by a standing wave of the same length and 18 m. high. As a consequence of this force, the intensity of pressure on the rubble mound, at the inner edge of the wall base, would have been expected to amount to 8.25 kg. per

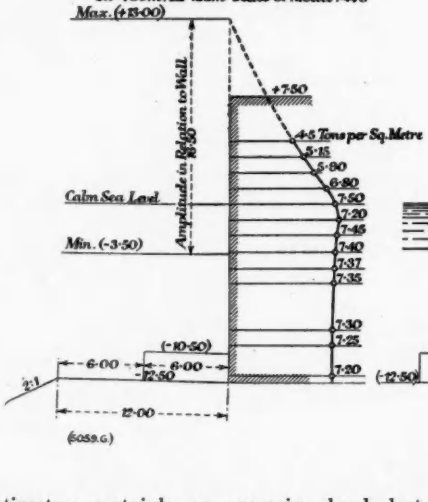
*The expression "standing wave" which is used above is not to be confused with the standing waves of flumes and weirs. It is a literal translation of the Italian onda stazionaria, which is the equivalent of the French claptotis, defined as "le résultat de la super-position de deux houles égales et de sens contraires. Ce mouvement se produit naturellement lorsqu'une houle rencontre un obstacle vertical perpendiculaire à la direction de sa propagation et s'y réfléchit de manière à donner naissance à une houle de sens contraire de même hauteur de vague et de même longueur d'onde qui se superpose à la première. (Prudon, Travaux Maritimes, Tome II, page 276.) The usual dictionary meaning of "ripple" for "clapotis" is, of course, inapplicable.

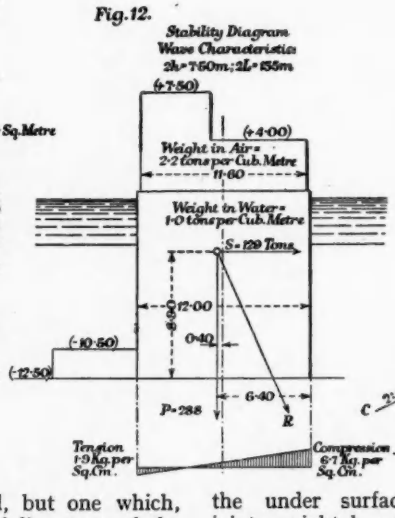
Stability of Vertical Wall Breakwaters—continued

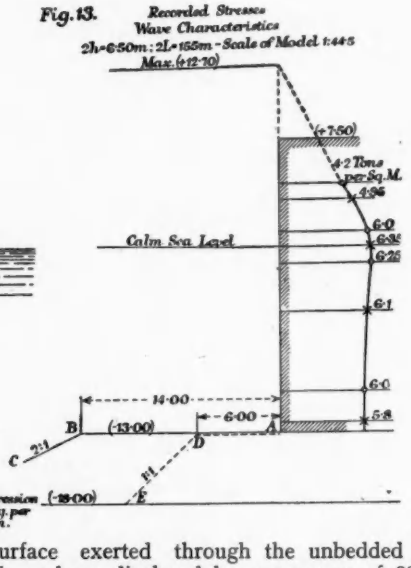












square centimetre; certainly an excessive load, but one which, very likely, was not actually realised to the full extent of the calculation, by reason of the intervention of other factors of resistance, such as the continuity of the mass concrete crown of the breakwater and the rise of the water inside the sheltered area as a result of the rise of the level outside.

(3) The model of the Catania mole having, in turn, been subjected to the impact of waves 7.50 m. high and 155 m. long adjacent to the structure, similar to those observed during the storm of March 26th, 1933, the results of the tests reproduced in Figs. 11 and 12 showed that the wall experienced total forces of 129 tons per lineal metre of structure producing an intensity of pressure on the rubble foundation of 6.70 km. per square centimetre; a pressure which the wall, 12 m. thick, would clearly have withstood better than the Algiers Jetty, if it had been, like the latter, constructed of piers of cyclopean blocks, formed with wells, afterwards filled in with concrete. It can be understood that the mass superstructure with the block immediately beneath, having a total weight of about 150 tons per lineal metre, as reduced, no doubt, by the pressure of the water on the under surface exerted through the unbedded horizontal joints, might have been displaced by a pressure of 60 tons and that subsequently the blocks in the lower layers would have been, in their turn, and still more easily, carried away.

(4) The results of all the experiments on small-scale models have enabled it to be determined that the intensity of the force exerted by oscillating waves against a vertical wall diminishes in the ratio of about two-thirds of the height above smooth sea level. Thus, with a surface level pressure of, say, 6 tons per square metre, at a height of 3 m., the pressure would be reduced by two-thirds of 3 m., i.e., by 2 tons to 4 tons per square metre. The pressure diagram is, in fact, substantially a triangle with a base angle of about 60 deg.

(5) In none of the three cases submitted to test with small-scale models, relating to breakwaters at Genoa, Algiers and Catania, situated in depths of 15 m., and 18 m., respectively, and having the bases of the vertical walls located at depths of 10 m., 13 m., and 10.50 m., could waves of the maximum heights of 7 m., 9 m., and 7.50 m. be caused to break, even superficially, in front of the wall, although given an increase

Stability of Vertical Wall Breakwaters—continued

of length in the open sea beyond admissible proportions, up to about 40 times their height. In all these cases, in fact, there was produced a maximum single force, almost exactly uniform over the whole immersed part of the wall and equal, as in all the other experiments, to the hydrostatic pressure due to the height of the waves. It is therefore justifiable to conclude that if the depth of the sea at the site of the work exceeds, as is usually the case, twice the height of the greatest storm waves to be expected in the locality, and if the foot of the vertical wall lies at a depth of one and a half times the same height, there should be no danger of waves completely breaking against the work. On the other hand, it has been possible to ascertain that under these conditions, the width of the bench at the foot of the wall and the inclination of the side slope do not affect in any way the intensity of the blow exerted by the waves against the wall (see Fig. 13).

But while under the foregoing conditions it is possible to exclude the risk of the complete breaking of the heaviest storm waves against the work, it is not impossible that, during storms attended by very strong wind, the waves, retarded in their propagation by the progressive decrease in sea depth and by the effect of the slope of the rubble foundation, may, under the influence of the wind, break superficially and so produce against a part of the face of the wall pressures which are much more intense than would be those exerted by the same waves if they remained purely oscillatory up to the point of contact with the wall. Unfortunately, no observations or experiments have supplied so far any data as regards the intensity and distribution of these exceptional pressures, so that no precise indication is available of the degree of additional support which may be required to counteract such wave action. However, it should be noted, on the one hand, that waves accompanied by strong wind are sensibly shorter than waves of the same height propagated in the complete absence of wind, with the result that the total force exerted against the wall is considerably less in the first than in the second case, and, on the other hand, that the force, purely dynamic, exerted by the breaking wave, exhausting itself in a comparatively short time, affects the wall by developing a tendency to shear much more than to turn over or slip. It follows, continued Professor Cagli, that, in his opinion, if the work is designed with the requisite margin of safety for withstanding oscillating waves of the maximum height to be anticipated in the locality, unaccompanied by wind, the monolithic structure of the wall itself, or its piers, may suffice to ensure the requisite stability in the event of the enhanced blows received during storms accompanied by strong wind, arising from waves of maximum height which happen to break superficially on approaching the wall.

Such are the results obtained so far by Professor Cagli, both from observations and tests on small-scale models. They are perhaps not exhaustive, but Professor Cagli considers that they suffice to substantiate the principles which he had previously enunciated in connection with the subject of the construction of vertical wall breakwaters* and which he embodied in his lecture in the following conclusions:—

(1) If the depth of the water and the rocky nature of the sea floor allow of its application, the best system of construction consists in founding the wall directly on the sea bed, having previously levelled the site with material not subject to deterioration in a marine environment. If, on the other hand, excessive depth of water or a soft sea floor require the formation of a rubble foundation, the latter should be constructed with the greatest possible degree of compactness. With that object, it is necessary to mix in bulk, quarry stone of varying sizes (the largest being used for facing) so as to reduce the volume of voids to a minimum. In addition to this, it is advisable in the case of mounds of appreciable height, to deposit the material in successive layers and as long as possible in advance of the contruction of the vertical wall, so that the rubble may have sufficient time to settle and solidify before receiving the weight of the wall.

(2) In principle, a vertical-wall breakwater should be avoided, or at any rate, that type of work must be considered disadvantageous, if the site is conducive to the complete breaking of storm waves. In the present state of experience, observation and research, whether theoretical or experimental, it appears that any danger of the complete breaking of storm waves in front of a vertical-wall breakwater is excluded when the depth of the water at the foot of the work is at least twice the height of the greatest storm waves likely to be encountered in the locality, whatever be their length, within the limits of actual observation (that is, from 35 to 40 times the height at the utmost in the greatest storm waves so far observed).

(3) Within the limits of depth practically imposed by the present state of constructional technique, the foot of the vertical wall should be located lower below sea level as the structure is more exposed, so that the largest waves anticipated may retain, while travelling over the slope and benching of the rubble mound, their oscillatory nature and that the mound itself shall not be exposed to disturbance from the motion of the sea. In accordance with the lessons gained from experience, so far, a depth of about 10 m. at the foot of the vertical wall directly exposed to wave blows, may be considered as sufficient if the anticipated height of waves does not exceed 4 or 5 m. In the case of works considerably more exposed, the depth should be increased to 12 or 13 m., at least.

In all cases it is advisable to ensure more satisfactorily the stability of the wall by embedding its base, suitably widened, within the rubble mound, rather than by protecting its outer foot by a line of guard blocks forming a projection on the rubble benching.

(4) The benching and outer slope of the rubble mound should be, the one all the wider (from 10 m. to 15 m.) and the other all the flatter (from 2: 1 to 3: 1) as the structure is more exposed and the sea floor more liable to disturbance. In the case of loose, earth, easily erodible and at no great depth, the adoption of the vertical-wall type of breakwater might entail the necessity, eventually prohibitive from an economic point of view, of protecting the bottom in front of the outer foot of the work over a considerable width, by suitable means, such as a layer of quarry stone laid directly on the ground or on a mattress of fascine work.

(5) Under the conditions stated in conclusion (3), the total maximum effort to which the wall may be exposed by the maximum wave stroke likely in the locality can be calculated on the basis of a unit pressure equal to the hydrostatic pressure due to the height of the wave in the open sea, applied uniformly throughout the whole extent of the wall below smooth sea level and decreasing progressively above that level at the rate of two-thirds of the height. But in selecting the type of wall structure, account must also be taken of the supplementary shock which may possibly be exerted by waves of the maximum height if, while approaching the breakwater, they happen to break superficially by reason of wind action.

(6) In the case of slightly or moderately exposed works, the wall may consist of a mass of bonded artifical blocks of ordinary shape and size. In the case of works much more or exceptionally exposed, it is necessary to have recourse to units of much greater dimensions, extending throughout the full thickness of the wall, such as cyclopean blocks superimposed, either in inclined layers, as is more particularly indicated for a wall founded directly on a rocky bottom, or in vertical piers, as is usually the case for walls founded on a rubble mound, or else consisting of monolithic sections formed by caissons of restricted width (5 m. or 6 m.) filled with concrete. These monolithic sections represent without doubt from the standpoint of stability, properly speaking, of the wall, the best solution, all the more recommendable now-a-days seeing that the cement industry is producing special aggregating materials which afford the surest guarantee of resistance to chemical action in sea water, to an extent no less than that of ordinary mortar made with rich lime

*"Sulle Condizioni di Stabilità dei Moli a parete verticale," Annali dei Lavori Pubblici, 1934, Fasc, 6.

Stability of Vertical Wall Breakwaters—continued

and pozzuolana. If, however, the local conditions are not of a nature to permit advantageously of the adoption of such a structure, an equivalent solution, having the merit of simpler and safer application, consists in building the piers in cyclopean blocks, with wells or cavities, capable of being converted into a single monolith by filling the wells with concrete, preferably reinforced with steel bars.

The monolithic structure of such piers, obtained by one or other of the methods suggested, has the advantage not only of increasing the resistance of the wall to overturning without increasing its width, but also of enabling it to withstand any additional force of impact exerted by the heavier storm waves should they happen to break superficially in front of the breakwater by reason of wind action.

In any case, whatever the structure of the piers, it is necessary to bond them by means of the super-structure (after allowing the piers to settle *pari passu* with the rubble base, especially in the case of a high mound foundation) with the object of making the whole wall, when its construction is completed, and further and unequal settlement is no longer to be feared, a solid monolith with suitable filling of the joints between the vertical piers.

The foregoing conclusions and deductions by Professor Cagli based on his wide and prolonged experience of harbour design and construction, must carry weight, and they will undoubtedly receive the earnest consideration to which they are entitled. They are specially applicable, of course, to the conditions obtaining on the littoral of the Mediterranean, which, it is to be observed, in contradistinction to the environment of ocean-bordered countries, is a tideless sea and, to that extent, free from certain perturbing elements which are to be encountered elsewhere. Moreover, the wave pressures experienced within that area, though considerable and shown capable of producing serious damage, would seem to be appreciably less than some which have been recorded on the coastline of the British Isles, more particularly on the exposed frontage of North-Eastern Scotland, where forces as high as 3 tons to 3½ tons per square foot (32 tons to 37 tons per square metre) have been noted.* It would be some recognition of the great utilily of the data determined by Professor Cagli and an acknowledgment of the value of the contribution he has made to current knowledge on the subject, if the respective authorities in various countries responsible for the maintenance of harbours and the safety of shipping were to realise the importance of such investigations, and by subsidy or otherwise enable research to be continued and extended so as to embrace the widest possible range of conditions affecting the stability of breakwaters, more particularly those of the vertical-wall type which has been adopted at so many ports in various parts of the world. In this connection it is to be noted that the Research Committee of the Institution of Civil Engineers has appointed a Sub-Committee on Wave Pressures, with Sir Leopold H. Savile, K.C.B., as Chairman. The Sub-Committee are conducting a series of experimental observations by means of gauges on the breakwater at Peterhead Harbour of Refuge, which should provide valuable information. Mention should also be made of the fact that at Algiers, where Monsieur Pierre Rénaud is Director and Engineer-in-Chief, apparatus has been in operation for some time for the purpose of studying the characteristics of wave action, both by means of small scale models and by direct measurement.†

Meanwhile, one outstanding lesson is to be learned from the experience of recent years, viz., that in the design of new breakwater structures it will be far-sighted and judicious policy to allow for the possible occurrence of storm waves appreciably exceeding in violence those which have been definitely recorded within the limited period of technical observation. Both at Catania and Algiers, as also at Antofagasta, the seas which brought about such calamitous results were considerably in excess of any which were to be expected from the records available.

*Stevenson, *Design and Construction of Harbours*, 3rd edition, 1886, pages 54-57. These pressures were, no doubt, due to waves which, passing from the purely oscillating type, had become more or less translatory, or breaking waves, but the conditions of impact on the dynamometers suggest some analogy with those under which the records at Genoa were obtained.

†An account of the installations and of the results obtained is given in an article by M. J. Larras, entitled "Recherches sur les jetées verticales," which appeared in the October, 1935, issue of Science et Industrie.

Warehousing Developments at the Port of Beira

Projected Establishment of Free Zone

The Portuguese Government through their Minister of Colonies, Dr. Vieira Machado, have announced their intention of establishing a "Free Warehouse Zone" for the Port of Beira in their South-West African Colony. A decree has been published in connection with the matter, containing the following provisions:

The exploitation of the quays, warehouses and other premises of the Port of Beira will henceforth be carried on under the system of a general free warehouse.

The delimitation of the area of the general free warehouse shall be effected, where it borders on the interior of the Colony, by means of a wall or railway or other form of obstacle to prevent the extraction of any goods deposited in the general free warehouse and subject to duties or other taxes levied by the Customs.

The commercial or industrial exploitation of the zone referred to shall be in the hands of the "Company of the Port of Beira" or other sub-concessionary undertaking to which that company may have transferred its rights and obligations under contracts in force.

In the zone occupied by the general free warehouse created by this decree, the privilege of issuing warrants on the goods therein deposited shall be exercised by the Company of the Port of Beira or the sub-concessionary undertaking referred to above.

No taxes or imposts, beyond the industrial tax, shall be due to the State by reason of the setting up of industries in the area of the general free warehouse.

Customs duties in accordance with the Customs legislation in force shall be due in respect of goods transformed in the general free warehouse on their leaving it to be consumed in or nationalised in the colony when such enter the said store.

No tax or impost shall be claimed by the undertaking engaged in the exploitation of the port from industries which may be established in the zone occupied by the general free warehouse of the Port of Beira beyond the rents arising from the lease of the sites occupied by the premises in question, as provided for by the contracts concluded between the parties.

The Governor-General is authorised to grant a reduction of up to 50 per cent. in the amount of industrial tax due by firms carrying on manufacturing operations in the area defined, where such operations involve the consumption of raw materials produced in the Colony and the production of goods essentially intended for export.

Goods produced in the Colony may be received in the zone occupied by the general free warehouse, without loss of origin, and also those nationalised in the Colony; they shall be stored separately under Customs regime, but may be used in blending operations or as raw materials for the industries, established in the general free warehouse. The goods shall enter the general free warehouse under a special entry ticket or permit.

In the special enclosure provided for them, goods produced in the Colony or nationalised therein, and cleared for export at other Customs stations, may remain while awaiting transport for their destination.

The release of goods from the general free warehouse shall be effected by the establishment of the requisite clearance note.

Legal Notes

Responsibility for Capsizal of Dredger in Port

An interesting case was heard in the King's Bench Division during the latter part of July affecting the responsibility for the capsizal in harbour waters of the twin-screw bucket dredger, *Don Federico*. The Great Western Railway Company, the port authority and owners of the vessel, claimed damages against the Port Talbot Dry Dock Co., Ltd., of Port Talbot in respect of the loss of the vessel in September, 1941, in the following circumstances.

The vessel was lying alongside a quay in lieu of being taken into dry dock for repair by the defendant company. Plaintiffs alleged that defendants removed pumps from the vessel, and omitted to blank off openings left in the skin of the dredger, or to see that the valves were closed. As a result, it was alleged, when heavy gear was removed from a storehouse on the port side of the vessel she developed a list to starboard. Water was in that way allowed to flow into the openings on the starboard side. As a result the dredger capsized and sank, and heavy expense was incurred in removing her from the entrance to the graving dock. Defendants were warned of the ingress of the water. Defendants denied negligence or that they were in possession of the vessel, or bailees for reward. They counterclaimed damages for loss, alleging negligence by plaintiffs, and delay in removing the wrecked vessel. They also alleged that their repairing quay was left partially obstructed.

Judgment.

The case came before Mr. Justice Tucker, who giving judgment on July 27th, for the railway company on the question of liability and remitting the case to the Official Referee for the assessment of damages, said that at the time of the loss the *Don Federico* was undergoing repairs by the defendant company, under a contract dated January 23rd, 1941. The contract provided that the dredger should be placed in dry dock, but, owing to the presence in the dry dock of a tanker the dredger, at the defendants' suggestion, was made fast to a quay outside the dry dock and alongside it. She was placed there for the purpose of the execution of the repairs, which were begun on September 22nd, 1941.

Mr. Justice Tucker read clauses from the contract and the specification of the repairs, which called for certain work to be done on the circulating pumps of the main engines, and the air feed and bilge pumps. It also provided that all skin fittings, inlets and discharges, " were to be opened out, cleaned, machined, ground in, repacked and closed up as before." There was also a provision that all gear was to be removed from the store-room on the port side, and the whole of the space be chipped, scaled and coated.

During the execution of the repairs the ship's engineer and a fireman remained on board during the day, and at night there were two firewatchers on duty. In the ordinary course the owners would have maintained night watchmen on board, and he was satisfied that precisely the same procedure was followed with regard to the persons who remained on board as in the case of a ship in dry dock. There was no alteration in any respect consequent upon the ship having been berthed outside the dry dock, and in his Lordship's view, on the evidence in the case and having regard to the terms of the contract, the *Don Federico* was at all material times in the care and custody of the defendants for the purpose of effecting the contract repairs. There could be no question that she was in the defendants' care and custody by day and he thought the conduct of their servants between 7.30 p.m. on September 24th and 7.30 a.m. on September 25th showed that the defendants recognised her as being in their custody at night as well.

His Lordship described the size and position of the circulating and air pump discharges and valves, and their method of operation. Before the defendants left the *Don Federico* on September 24th, he said, the cover from the air pump and the casing from the circulating pump had been removed. Before leaving the vessel in that condition, the foreman engineer, named Bate—the man in charge of that part of the work—had not inspected either of those discharge valves, situated only three inches above the waterline, to ascertain that they were properly and securely closed. Furthermore, at some time between 4.30 and 6.30 that evening, the defendants' men had been removing heavy gear from the storeroom on the port side, and by 6.30 the ship was listing slightly to starboard. He had no doubt that that was caused by the removal of the heavy gear; nor had he any doubt that the list brought the air pump discharge valve below the water level, with the result that water entered the engine-room. That was discovered by the night watchman Lewis Lewis—an excellent and reliable witness—about 7.30 p.m. He promptly reported the matter to the Dry Dock watchman, who suggested sending for assistance, and at 8.15 p.m. a machinist named Scourfield arrived. He observed that the water was welling up out of the air pump chamber, and he went to the discharge valve. He turned it and said it came down and made a click. Scourfield did his best in the circumstances and thought the matter was rectified, but he very properly reported it to Bate, who did not consider it necessary to go to the ship to see whether the leak had been properly stopped. Nor did he think it necessary to ensure that the main discharge was properly closed. What he did was to send a message to the night watchman that the water had stopped, but that they were to keep their eyes open and report to the Dry Dock watchman if there was any renewal.

Scourfield, on his return, took to the ship the foreman boilermaker, and they were both satisfied that water was no longer coming in. That was at 9 p.m. Bate's message was conveyed to the night watchmen, and his Lordship was satisfied that they were also told that everything would be all right, and there was no cause for anxiety. Those instructions and that opinion were passed on to the watchmen who came on duty at 11.45. Everything then appeared to be in order, and no change was seen on a later inspection. By 6.30 next morning water was all over the stokehold, and one of the watchmen, realising that the position was serious, reported to one of the defendants' men on the dry dock. His Lordship was satisfied that that report was made promptly, and he did not think any serious criticism could be made with regard to the acts or omissions of anyone thereafter. But they were not able to get pumps working in time to save the dredger, and she capsized and sank shortly after 7.30 a.m.

Mr. Justice Tucker referred to efforts made by a man named McClure and another man named Galley to remedy the situation, and said he was satisfied that by 7.30 a.m. water was pouring in at both discharge valves. He found that the effective cause of the sinking was the omission to take steps to ascertain that the discharge valves were properly closed before the pumps were dismantled and the gear removed from the store on the port side. He did not think it necessary to decide whether it was negligent not to blank off the discharges. It was sufficient to say that having regard to the nature of the repairs being executed and the removal of the gear from the storeroom, coupled with the unusual proximity of the discharges to the waterline, it was incumbent upon the defendants to take proper steps to see that the discharge valves were securely closed. Thas was, in his view, clearly the duty of the defendants, and not the responsibility of the ship's engineer.

As to the allegation of contributory negligence, his Lordship referred to rounds made by the night watchmen during their period of duty. Having regard to the position and qualification of the night watchmen, and accepting their evidence; taking into consideration the circumstances existing when they went on duty and the instructions they received coupled with the admitted position in the engine-room at 1.30 a.m., his Lordship was not prepared to say that they failed to exercise that degree of care and skill to be expected of persons in their position. It was to be remembered that, as a result of Bate's decision, no properly qualified person ever inspected the engine-room between 9 p.m. on September 24th and 7 a.m. next day. He thought it impossible for the defendants to shift the responsibility for the accident on to the night watchmen.

Those findings were sufficient to dispose of the issue of liability, but he thought he ought to state his conclusions with regard to Clause 15 of the general conditions of the contract. That read:—

> " The contractor shall be responsible for and shall save harmless and indemnify the company from and against all actions, claims, losses and expenses whatsoever in respect of loss of life or personal injury or loss of or damage to property howsoever caused arising out of or in any way attributable to the execution

Legal Notes—continued

of the works including claims under the Workmen's Compensation Act and the Employers' Liability Act."

It was contended by the defendants that that clause applied only to third-party claims, and did not include damage to property the subject-matter of the contract.

His Lordship said he had given careful consideration to the authorities which had been cited, but, as the clauses in each case differed materially from that with which he was concerned, he had been unable to derive much assistance from them.

Mr. Morris, for the plaintiffs, had said there was no reason to exclude damage to the plaintiffs' property, whether that property was a ship under repair or any other property, provided always that the damage arose out of or was attributable to the execution of the works. In his Lordship's view the words " be responsible for " governed all the words that followed, and, as applied to " losses and expenses," extended the meaning which the clause would have had if the governing words had been words of indemnity only. He saw no reason to restrict the clause to third-party claims, and, unless it was restricted, there was no ground for excluding losses arising from damage to the subject-matter of the contract. For those reasons, if he had arrived at a different conclusion regarding negligence and contributory negligence, he would have found on the facts that the loss of the vessel arose out of and was attributable to the execution of the works and would have held as a matter of law that it was within Clause 15 of the general conditions.

In the result the counterclaim would be dismissed, and the claim would be referred to the Official Referee to assess the damages and enter judgment accordingly. The defendants must pay the costs of the claim and counterclaim.

Handling of Refrigerated Meat Imports

Co-operation of Rail and Road Services at Ports

(COMMUNICATED)

In a survey issued by the Railway Executive Committee showing the part which the railways have been taking in the inland transport of meat, the fact is disclosed that the pooling of all rail and road insulated vehicles at ports was the principal means of maintaining the national meat ration in 1941.

To deal with imported meat traffic, the railways now have at their disposal 2,429 rail-road meat containers and 2,691 meat vans specially insulated for carrying refrigerated products at low temperatures. They are also making good, even though temporary, use of 3,471 insulated banana vans for this traffic. These vans have proved very useful for the conveyance of frozen freight. The railways also control and supervise the working of 42 35-ton bogie refrigerator cars owned by the U. S. Army now in use in this country.

Shortage of Insulated Vehicles

In 1940, shortage of insulated rail and road vehicles at the ports was affecting the turnround of ships, losses due to this cause being estimated at 200,000 tons a year. A national scheme which would increase the number of insulated vehicles at the ports and provide greater flexibility in the use of rail and road units by co-ordination, was clearly necessary.

On the 1st December, 1940, under the chairmanship of the Port Food Movement Officer, small committees were set up at each port concerned, which met daily to consider the tonnage of imported meat to be conveyed by rail and road respectively according to the prevailing conditions, transport available, destinations and tonnage.

A standing central committee known as the Central Meat Stock Distribution Committee, was established as a co-ordinating authority for the country as a whole, with power to make any adjustments considered necessary in the tonnage allocated to rail and road respectively by the Port Committees, after taking into consideration the circumstances at all the ports concerned, at inland cold stores, any cross haulage and prospective commitments.

Pooling of Transport

With the encouragement of the Ministry of Food a pool of insulated road vehicles had been formed at the beginning of the war under the aegis of the Wholesale Meat Transport Association and at the suggestion of the Ministry, the railways, as a preliminary to the general and more comprehensive scheme, decided that pooling of the whole of their insulated rail vans and containers and the establishment of a central authority for their control and distribution would bring immediate benefits. These arrangements were completed and brought into operation by the railways on the 1st November, 1940, only one month after they had been first mooted. The objects were to enable the combined insulated resources of the country to be concentrated at the required ports, via the shortest routes; to obtain greater utility by a more flexible control of both rail and road vehicles and to effect a reduction in empty haulage.

The very close co-operation under the scheme of rail and road transport has reduced to negligible proportions delays to the refrigerated ships by reason of the shortage of insulated vehicles.

Meat Importations

The 8,600 vehicles used for meat traffic are in constant use to deal with the meat imports and other frozen products from abroad, the greater portion of which the railways are called upon to carry from the ports. Last year, for example, out of a total of over a million tons of meat imported into this country, the railways carried 617,500 tons or 62 per cent. Since the outbreak of war there has been, in fact, a continual increase in the amount of meat carried by the railways from the ports. In 1941, the average weekly dispatch amounted to 9,332 tons: in 1942 this figure rose to 10,321 tons. A further increase was recorded in 1943 with a weekly average of 11,874 tons, whilst so far this year a " new peak " has been reached with an average dispatch of 12,776 tons a week. This latter figure shows an increase over 1941 of 37 per cent.

Although the amount of meat imported fluctuates considerably from week to week, during a typical week some 25 special meat trains are worked from the ports in addition to the regular services. In one particular week this year the railways carried no less than 25,641 tons from the ports, and Cold Storage Depots, a movement which involved the use of 4,643 insulated vehicles.

A considerable proportion of imported meat is sent direct from the ports to Cold Storage Depots for subsequent distribution by road to consuming places in the vicinity. As a general rule, however, the railways carry the long distance traffic from these stores. It is estimated that meat from the ports and cold stores is conveyed by rail over an average distance of 127 miles to nearly 700 different centres of population.

In addition to their stock of vehicles for the carriage of frozen meat, the railways are using 1,506 meat vans and 421 road-rail meat containers for carrying freshly killed meat. They also have in operation 14,038 cattle trucks for the conveyance of livestock. During the last few years the number of livestock forwarded has steadily increased. In 1941 an average of 6,145 trucks were being despatched each week; in 1942 this figure was increased to 6,311, and in 1943 it rose to 6,715, an increase compared with 1941 of 9.3 per cent. October generally provides the heaviest loadings when over 12,000 wagons of livestock have been carried by the railways in a single week.

Coincident with the increase of livestock by rail there has been a decrease in the tonnage of fresh meat conveyed. In 1941 the average number of vehicles despatched weekly with fresh meat was 432, with a maximum of 868. Last year the average was 217, with a maximum of 384. This decrease is due to the limitations imposed by zoning.

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The Care of Ropes

Their Storage and Maintenance

By A. G. AREND.

Rope Stores

Those who have had the opportunity of studying the conditions which obtain in not a few large stores will confirm that rope is not always accorded that care which ensures for it the longest period of useful service and the maintenance of maximum strength. As the present conditions in the Far East have caused a certain restriction in supplies of the best raw material, the matter of acquiring the best service from existing stocks has become more important, although this does not apply in the same way to iron and steel ropes. Where great strength is not essential, jute suffices for most ropes from sizes of one inch downwards, but superior fibres are necessary for all others. As a certain amount of substitute addition to these best fibres has been deemed desirable by many manufacturers, only a reasonable performance compared with that of the best manila grades can be expected, but this does not suggest that they should be given less attention. The early style of store simply comprised any odd building equipped with loading banks, and conveying appliances, etc. To-day, the direct economies gained by introducing air-conditioning in other departments have aroused more interest generally in atmospheric influences, but it is doubtful if this has as yet been considered for the large store, although it is fully recognised in different textile storages. Moisture, or dampness of any kind, is injurious to rope, but in hanging up to dry, freezing represents an even more serious feature, as this not only causes injury to the fibres, but impairs the strength, since a certain cutting action is evident. Alternatively, heat reacts in another manner, this causes the oil to dry out of the fibres, whether the source is from nearby boilers, or from the rays of the sun. One bad practice in at least some large stores is to find large coils of rope on the floor, thus preventing the material from realising its longest possible life, while large boxes and cases, used as containers, are likewise highly undesirable. Where ropes cannot be hung on wooden pegs in loose coils, they should be stored on grating platforms of wood, at least half a foot from the floor level, which gives the air good opportunity to circulate freely. For lengthy storage, ropes should be kept in a dry, but not hot, atmosphere, out of contact with weather or sun, as moisture, not only causes kinking, but hastens decay. Where the conditions permit when it begins to rain, guys between fixed fittings outdoors should be slackened off. This is simply because damage can occur to shrinkage straining the fibres excessively, and represents a small point frequently overlooked. Almost any kind of fumes are undesirable to the fibres, but particularly those of acid, and where this has caused a full discolouration, the rope should be discarded as its strength can never be relied upon. After the last war period, a number of instances came to light where defective rope had been disposed of for what it would fetch, and this for any form of rigging or scaffolding work could lead to danger to human life.

As a consequence, in more responsible quarters to-day when it is feared that parts of the rope have been impaired, it is condemned and purposely cut up into short lengths, so that it will not readily be utilised for hoisting purposes.

Approximate Testing and Examination

The testing of ropes in the modern rope factory is of an exacting character, accompanied by microscopical examinations of the fibres themselves, and is beyond the capabilities of the ordinary consumer. Only rough approximate tests can be made, but if these are carried out with precision a good indication of their condition can be gathered. By inspecting the outside yarns throughout every foot, broken fibres reveal a corresponding loss of strength for every failure, but this has to be supplemented by un-twisting the strands to open up the rope to ascertain whether or not the internal condition has been likewise affected. Dirt on the outside cannot be prevented in service, but once this enters and causes the inner strands to unlay, the material is not safe for hoisting purposes. When an inspection shews that the life or elasticity is lacking, any load applied will not be evenly distributed amongst the strands.

Although rope may be somewhat old, the interior fibres should be bright and clean as when new, and hence surface dirt or discolouration should not be over-estimated. When ropes have been suspected of receiving overloading treatment, one fortunate feature of examination is that on opening up the strands the interior yarns will reveal the character, i.e., they will fail first on pulling out. In a like manner, where four-strand rope is laid around a heart, the latter will come out in short pieces when a pulling action is exerted. When breaking individual fibres pulled out from the end of the rope with the fingers, it has to be remembered that the coarser ones are relatively weak, and the finer strands represent the strong product. In extreme cases, where excessive internal wear has existed between the strands, an examination will shew an accumulation of fine powder of sawdust-like appearance. Without entering into microscopical investigations, which in this work are assisted by the use of the stereoscopic effect, or "three-dimensional-seeing," a glance through a good magnifying glass will indicate the nature of these particles. Some forms of rope are much more adversely affected by heat than others. Thus sisal rope when heated not only becomes hard and brittle, but lubricates with difficulty, and when the surface feels dry, perhaps by being in contact with hot pipes, etc., it should not be used for hoisting.

One type of rope specially made for stevedoring purposes where abrasive influences are likely to abound, is purposely made so that it is several per cent. harder than the regular sisal rope, but it does not, however, compare favourably with the greater strength of the best qualities of manila rope. The best sisal ropes approximate to three-quarters the strength of the latter, and are harsher to the touch and more coarse and brittle, besides shewing a whiter appearance than manila rope.

Manila has a smooth waxy surface, and the best qualities have a slightly yellow shade and silvery lustre, and can usually be distinguished by a coloured strand.

For resistance to abrasion, the strands are tightly twisted in order to make the product stiff, but for acquiring the maximum strength, the soft-laid or more loosely twisted rope is preferred. Although manila rope is mostly made up of three strands, four strands laid around a core is preferred where abrasive influences are to be expected.

The Breaking of Ropes

The breaking of ropes has been under scrutiny for many years, because seemingly safe loads have sometimes been found to cause disruption. At the commencement, ordinary hard service and ageing can cause not only some of the yarns to become broken, but also to dry-out, whereby the tensile strength can be reduced by at least a quarter of its original figure. Although it is customary to bend ropes round pulleys, etc., the more bending the individual fibres receive the more has to be substracted from the original average strength, because of additional stresses. A good illustration of this is seen in the figures quoted by the Consolidated Edison Company of New York, where the original breaking strength of rope was expected to be 4,900 lb. when new, but some lengths of which could not be expected to be beyond 4,800 lb. With a quarter of this dissipated by regular service conditions, the figure could be reduced to 3,600 lb., while bends and knots cut this down further to a half, or 1,800 lb. The expected safety factor might thus be in jeopardy, as with an original figure as high as 4,900 lb., the rope in practice might reasonably be regarded as suitable for loads a third of this amount in the ordinary way, though this is too near the limit for safety. In ordinary usage, there are too many different factors which can affect the strength for any really definite allowance to be made for loss, and hence the necessity to keep the rope in as fresh condition as possible, so that a better criterion can be gathered in figuring out safety factors. This relates to having ropes properly protected from sharp ends of boxes, cases, castings, beams, etc., by padding, while equally important is the avoidance of dragging ropes through sand, or sharp-surfaced material, where apart from abrasive action, gritty particles can get between the strands. Attendants who are really experienced, know how to diminish the loads dealt with as service continues, but where particles have caused internal damage, the fixing of a safety factor

(Concluded on page 116)

Retaining Walls

An Article for Students and Junior Engineers

By STANLEY C. BAILEY, Assoc.M.Inst.C.E., F.G.S.

(Concluded from page 86)

Types of Walls

Figs. 7 to 13 show various types of gravity walls, and Figs. 14 to 17 those constructed of reinforced concrete. In Fig. 7 the wall is formed of rubble masonry with either a rubble masonry face, or one built of either coursed ashlar stonework, or rock-faced squared stone, set in 1 to 2 cement mortar.

Fig. 8 shows a brick-built wall, which may be either vertical or inclined, if the latter the base should have the same inclination as that of the fact, the dimensions should be in multiples of brick sizes, and they may be laid either in English or Flemish bond, in 1 to 2 cement mortar, as the strength of both brick and masonry walls depends more on the strength of the mortar used, than that of the brick or stones. Soft bricks weigh 93 to 106 lbs. cub. ft. hard sand bricks—108 to 114 lbs., hard clay bricks—118 to 138 lbs. perforated clay bricks 95 lbs., and blue bricks—132 to 147 lbs. per cub. ft., so that brick-built walls will require to be thicker than stone or concrete ones. Drainage holes in brick walls are best formed by leaving 6-in. by 2-in. gaps between the bricks.

Fig. 9 illustrates a typical mass concrete wall, the concrete proportions may be either 1-2-4 or 1-2½-5, and large clean stones or "plums" may be embedded in the body of the concrete. The walls are constructed inside either timber, sheet steel, or cast iron shuttering, in convenient sizes for handling and well greased or limed on the surface next the concrete. Timber planks should be 1½ to 2-in. thick and have V-shaped or tongued and grooved joints, as liquid concrete exerts a fluid pressure of 70 to 85 lbs. per cub. ft. The concrete blockwork wall shown in Fig. 10, is a convenient form of construction as no shuttering is required, the blocks should be formed in metal or timber moulds of 1-2-4 cement concrete and should be solid, say 2-ft. by 1-ft. by 1-ft. (280 lbs.), or 1-ft. 6-in. by 9-in. by 9-in. (118 lbs.), a small crane will be required to handle them, and they should be laid in alternate courses of headers and stretchers, in 1 to 2 cement mortar.

Gravity walls should not be constructed of hollow blocks, as it is important that they should have weight.

Concrete formed of 1-2-4 river ballast weighs 142 to 147 lbs. cub. ft. sandstone concrete of 1-2-3 weighs 145 lbs. and whinstone 134 lbs., while reinforced concrete of 1-1½-2⅔ crushed granite weighs 148 to 150 lbs. per cub. ft.

In Fig. 11, the wall consists of a number of buttresses about 10-ft. apart and 2 to 3-ft. thick on a continuous concrete foundation; the reinforced concrete slabs forming the face of the wall are 1-ft. 6-in. to 2-ft. wide and 6 to 9-in. thick, according to the pressures they are required to sustain, and are dropped in grooves from 4 to 6-in. deep in the buttresses.

The horizontal joints of the slabs may either be square or formed with a semi-circular tongue and groove, the joint being made in 1 to 2 cement mortar. The advantage of a continuous concrete foundation is that the pressure, instead of being concentrated on the ground under the buttresses, is spread over a greater area, than if the foundation concrete was confined to the buttresses. If the concrete foundation of a reinforced concrete wall is projected horizontally some distance in front of the toe as shown in Fig. 14, the pressure on the ground will be much more equalised.

In reinforced concrete walls, rapid changes in the section should be avoided, and good splays put at the angles, for these are the points of weakness.

Reinforced concrete walls of L-shape are prevented from overturning by the weight of the mass of earth resting on the lower limb, and included between the back of the wall and a vertical line at the end of the horizontal limb of the L, but the actual weight may easily be more than this, as the mass of earth may include that between the back of the wall and a line drawn from the end of the limb to half-way between the plane of rupture, and the vertical, at the surface, this will depend upon the internal friction of the soil, and is shown at A-B in Fig. 17.

Calculations for Reinforced Concrete Walls.

Figs. 18 and 18a show the calculations for an L-shaped reinforced concrete wall 33-ft. high with a base 16-ft. wide, and without any ribs at the back. The plane of rupture of the earth has been assumed at an angle of 60 degrees. The vertical weight of the earth is 18.4 tons per lin. ft., and the horizontal pressure 10.6 tons, the backing and filling being taken at 118 lbs. cub. ft., or 19 cub. ft. per ton; the concrete has been taken at 149.3 lbs. cub. ft. (15 cub. ft. per ton) and the weight of the wall is 5.7 tons per lin. ft.

The weight of the backing bearing on the foundation limb of the wall is 19.5 tons, which added to the weight of the wall totals 25.2 tons.

The pressure on the ground at the toe (Fig. 18a) amounts to 3.58 tons per sq. ft. and at the back there is uplift equal to 0.4 ton.

The moment of the wall and backing is 25.2 x 8.75-ft. = 220.5-ft. tons and the moment of the earth pressure = 10.6 x 10.75-ft. = 113.95-ft. tons, giving a factor of safety of 1.93 against overturning.

The resistance to sliding, neglecting the passive resistance of the soil at the toe, will 25.2 x 0.5 = 12.6 tons for dry, and 25.2 x 0.3 = 7.56 tons for wet ground, and as the earth pressure is 10.6 tons, the wall may slide on moist soil, but the resistance can be increased by carrying the toe further into the ground as shown by the broken line in Fig. 18.

In the calculations for the bending moments on the wall, the earth pressure of 10.6 tons = 23,744 lbs. and $\frac{33' \times 33'}{2} \times 1' = 544.3$ cub. ft., therefore $\frac{23{,}744}{544.3} = 43.6$ lbs. cub. ft. equivalent fluid pressure and 33 × 43.6 = 1438.8 lbs. pressure at the base per lin. ft. of wall.

Make D, E equal to this to any convenient scale, and complete the triangle D, E, F, then the pressures at any point in the height of the wall can be obtained. The pressure at 29.6-ft. from the top of the wall is 1,280 lbs. per sq. ft. and the bending moment at

$$C = \frac{P.L}{2} \times \frac{L}{3} = \frac{1280 \times 29.6}{2} \times \frac{29.6}{3} = 186{,}788 \text{ ft. lbs.}$$

Taking M = 186,788 × 12 = 2241,456-in. lbs., and the thickness of the wall at the base = 30-in., with an effective depth d = 27-in., and the safe compression on the concrete = 700 lbs. per sq. in., then the proportional depth of the neutral axis from the compression side will be

$$Z = \frac{M}{b.d^2 \times 700} = \frac{2241456}{12 \times 27^2 \times 700} = 0.366$$

for a 12-in. long section of the wall, see diagram "Section at C."

U = 0.366 by 27-in. = 9.88, say 10-in., Y = 17-in., h = 0.4 x 10-in. = 4-in., x = 6-in. and the lever arm (a) = 23-in.

The area of the steel required $= \frac{M}{a \times 16000} = \frac{2241456}{23 \times 16000} =$ 6.0 sq. in.

Therefore 2 rods ⅝-in. d. = 0.6, 4 rods ¾ d = 1.76 and 4 rods 1⅛-in. d = 3.96 sq. in., a total of 6.32 sq. in.

The actual stresses will be as follows, the moment of inertia being equal to about 33.600 in. units:

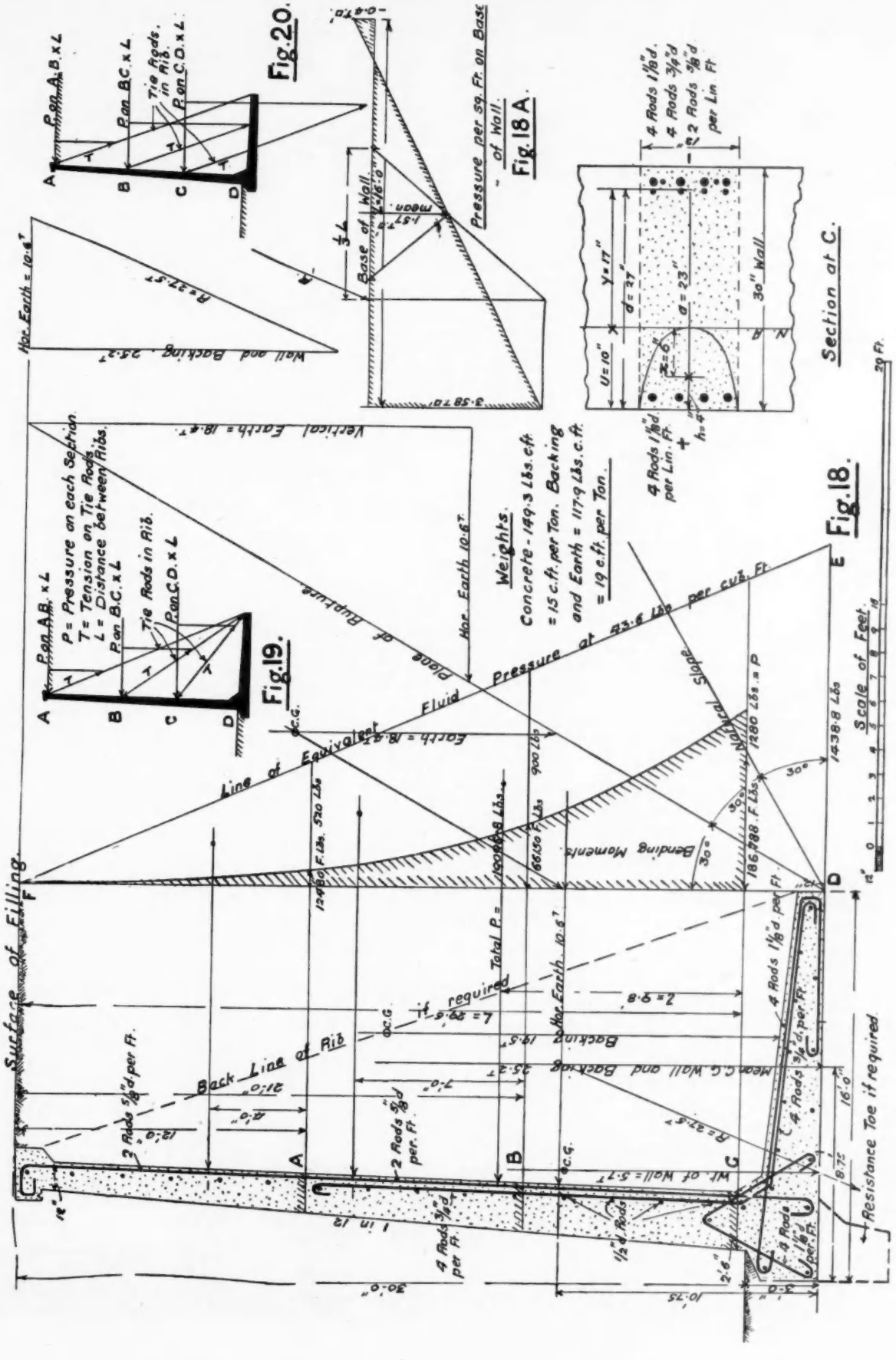


Fig.20.
Fig.18A.
Fig.19.
Fig.18.
Section at C.
Weights.
Concrete - 149·3 Lbs c.ft.
= 15 c.ft. per Ton. Backing
and Earth = 117·9 Lbs. c.ft.
= 19 c.ft. per Ton.
Pressure at 43·6 Lbs per cub. Ft.
Fluid
Bending Moments
Surface of Filling
Back Line of Rib
Resistance Toe if required
Scale of Feet

Retaining Walls—continued

$$\text{Stress in concrete} = \frac{M.U}{I} = \frac{2241456 \times 10}{33600} = 667 \text{ lbs. sq. in.}$$

$$\text{Stress in steel} = \frac{M.y.m.}{I} = \frac{2241456 \times 17 \times 15}{33600} = 17{,}011 \text{ lbs. sq. in. (7.5 tons).}$$

$$\text{Stress in + steel} = \frac{M.x.m.}{I} = \frac{2241456 \times 6 \times 15}{33600} = 6003 \text{ lbs. sq. in.}$$

m is the ratio of the elasticity of the steel (30,000,000) to that of the concrete (2,000,000), which in some countries is taken at 12 in lieu of 15. The safe stress on the steel in tension is 16,000 to 17,000 lbs. per sq. in. and for compression 9,000 lbs. sq. in. (4.01 tons) to 12,000 lbs. (5.3 tons) and in shear 12,000 lbs. sq. in.

The bending moments at B and A in the diagram are obtained in a similar manner to the above. At B the percentage of steel in the concrete area is 0.8% and where it does not exceed 1.5%

$$Z = \frac{15 \times 700}{16000 + 15 \times 700} = 0.39.$$

In the horizontal limb of the wall, the steel should be arranged near the top, as the upper portion will be in tension.

If ribs are added to the back of the wall as shown by the broken line in Fig. 18, at intervals of 8 to 10-ft. apart longitudinally, the vertical face of the wall becomes a slab, with fixed supports at the ribs, and its thickness can be reduced from 6-in. to the top to 8-in. at the foot of the wall.

The main rods will be horizontally placed near the outside in the middle of the span, and near the inside at the ribs, while the distribution rods will be vertical. The bending moments will be as for continuous beams.

The ribs will act as cantilevers carrying the load on each span, and the reinforcement in these may be arranged on either of the two systems shown in Figs. 19 and 20 in which the amount of tension is graphically shown in proportion to the load carried by each tie rod. The thickness of the ribs will depend upon the reinforcement required, but usually from 6 to 8-in. will suffice, the rods having a covering of 2-in. of concrete to prevent the penetration of moisture. The main steel rods in the lower limb of the wall should be near the underside which in this case will be in tension, and should be arranged transversely, while the $\frac{3}{8}$ or $\frac{1}{2}$-in. distribution rods can be placed longitudinally from 12 to 18-in. apart.

Canadian National Harbours Board

Annual Report for 1943

Shipping and Cargo Tonnage

The recently issued Annual Report of the National Harbour Board of Canada contained the following information about operations during the calendar year 1943.

Vessel arrivals in 1943 numbered 39,041, the aggregate net registered tonnage being 27,400,898. In 1942, the comparative figures were 43,432 vessels of 32,680,820 net registered tons.

In 1943, the aggregate volume of water-borne cargo tonnage, inward and outward, was 4 per cent. greater than in the previous year. The figures for 1943 were 22,928,404 tons, as against 22,089,516 tons in 1942, an increase of 838,888 tons.

During the war, explanatory comment on shipping and cargo figures, as well as the publication of traffic statistics of individual harbours, are withheld.

Revenues and Expenditures

Operating revenues of all units under the administration of the board amounted $10,861,081 in 1943, as compared with $10,416,805 in 1942. The increase was $444,276, or 4 per cent. Expenses of administration, operation and maintenance were $5,277,574 and showed only a slight increase over those for 1942, when expenses totalled $5,219,781, the difference being $57,793. Operating income for the year was $5,583,507, as compared with $5,197,024 in 1942, an increase of $386,483, or 7 per cent.

After taking into account miscellaneous debits and credits to income, and charging interest and reserve for replacements, the operations for 1943 resulted in a net income deficit of $4,086,204. The corresponding figure for 1942 was $4,547,935. The net gain over 1942 was, therefore, $461,731, or 10 per cent.

The Report is signed by R. K. Smith, Chairman, J.E. St. Laurent, Vice-Chairman, B. J. Roberts and F. W. Riddell.

Care of Ropes

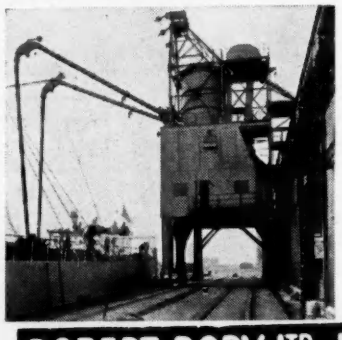
(Concluded from page 113)

is something of a guess. This assumes greater importance with the restrictions on the best manila rope supplies, as substitute materials are known to be less dependable.

Whippings should always be applied immediately rope has been cut. If this is done later, it has given some strands the opportunity to become unlaid, and once one of these is loose, or slips in relation to the others, distribution of the load is rendered unequal. As the strengths of jute ropes are not considerable, these need not be compared with the superior fibres, and on account of the limits imposed on Java sisal and the product from Manila, attention has been devoted to those from Cuba, Mexico, and elsewhere, which rarely have a strength beyond some 65 per cent. of the best manila rope. Sisal ropes have from 70 to 75 per cent. the strength of Manila rope, while mixtures of these have also been tried, but the pure material of one inch diameter is quoted at only 584 lb., compared with 900 lb. safe working load for manila. It should be added that greater progress would probably have been made in developing the strengths of rope had driving by ropes become more popular, but it has been severely competed with by individual electrical drive.

In conclusion, reference should be made to the use of the small direct-contact microscope, Swiss makes of which were introduced just prior to the war, and which are invaluable for making a rough examination of fibres without previous mounting of specimens, as is necessary with the biological microscope. All that has to be done is to place the pulled-out fibres on a piece of clean paper, arrange the extent of magnification to any fixed degree up to 70 diameters on a sliding cylinder, and regulate the focussing. The darker fibres from the outer portions of the stalk are weaker and less durable than those nearer the centre, and the presence of substitute fibres can be readily detected at a moments notice. It is contended that as a result of the necessity of having to utilise inferior fibres, more frequent testing, inspections, and lower rope loadings may be required in the near future.

FOR DOCKS, PORTS AND RAILSIDE



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